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July 20, 2005

OTTER TAIL
POWER COMPANY

Mr. Kyrik Rombough
Air Quality Program
South Dakota Department of Environment
and Natural Resources
Joe Foss Building
523 East Capitol
Pierre, SD 57501-3181

Dear Mr. Rombough:

Subject: Prevention of Significant Deterioration Construction Permit Application
Big Stone II

Enclosed are four copies of the Prevention of Significant Deterioration Construction Permit Application for the addition of Big Stone II to the existing Big Stone Plant site. Also enclosed is the $100 filing fee as specified in the Administrative Rules of South Dakota 74:37:01:04.

Otter Tail Corporation dba Otter Tail Power Company is making the filing on behalf of the Big Stone II co-owners:

- Central Minnesota Municipal Power Agency
- Great River Energy
- Heartland Consumers Power District
- Montana-Dakota Utilities Co., a Division of MDU Resources Group, Inc.
- Otter Tail Corporation dba Otter Tail Power Company
- Southern Minnesota Municipal Power Agency
- Western Minnesota Municipal Power Agency

I look forward to working with you on this project.

Sincerely,

Terry Graumann
Manager, Environmental Services

Enclosures

Big Stone II

Prevention of Significant Deterioration Construction Permit Application

Prepared for
Big Stone II Co-owners

Big Stone City, South Dakota
July 2005

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EXECUTIVE SUMMARY

Pursuant to the requirements of Administrative Rules of South Dakota (ARSD) Chapter 74:36:09 and 40 Code of Federal Regulations (CFR) Part 52.21, the Big Stone II Co-owners are submitting this Prevention of Significant Deterioration (PSD) permit application for the installation of one (1) nominal 600 megawatt (MW) net baseload super-critical pulverized coal-fired unit and ancillary equipment (Project). The new unit will be located at the existing Big Stone Plant site located in Grant County, South Dakota, an attainment area for all criteria pollutants.

This application is being made by Otter Tail Power Company on behalf of the Project Co-Owners:

- Central Minnesota Municipal Power Agency (CMMPA);
- Great River Energy (GRE);
- Heartland Consumers Power District (HCPD);
- Montana-Dakota Utilities Co., a Division of MDU Resources Group, Inc. (MDU);
- Otter Tail Corporation dba Otter Tail Power Company (OTP);
- Southern Minnesota Municipal Power Agency (SMMPA); and
- Western Minnesota Municipal Power Agency (WMMPA).

The Project will consist of a new pulverized coal-fired boiler to power a steam turbine generator, associated pollution control equipment, auxiliary equipment, cooling tower, and materials handling equipment. The boiler will be fired by Powder River Basin subbituminous coal delivered by rail to the site. Potential emissions from the boiler and associated equipment are given in Table ES-1. The emissions in Table ES-1 are based on the Emissions Estimates in Section 3 of this application and the Best Available Control Technology (BACT) analysis in Section 5 of this application. These emissions represent the combustion of coal in the new boiler, proposed emissions reductions from the Big Stone Plant unit I boiler, other emissions associated with the boiler addition, and emissions from the cooling tower. A full description of new equipment being added as well as modifications to existing materials handling equipment and the new requested limits is given in Section 2. Potential emissions are based on a maximum firing rate and continuous operation (8,760 hours per year).

Table ES-1: Projected Emissions and Significance Levels

Pollutant	Potential Emissions Increase (TPY)	PSD Significance Level (TPY)
CO	4,262.18	**100**
NO_x	39*	40
PM_{10}	932.91	**15**
SO_2	39*	40
VOC	106.16	**40**
Lead	0.47	0.6
H_2SO_4	131.40	**7**
Fluorides	15.77	**3**

*Net emissions increase including effect of contemporaneous reductions from Big Stone unit 1.

Plant Wide Emissions Cap for SO_2 and NO_x

As part of this project, the existing Big Stone unit I flue gas will be ducted to a wet flue gas desulfurization (WFGD) system to control SO_2 emissions from Big Stone Plant unit I and Big Stone II. Emissions of NO_X from the Big Stone II boiler will be controlled by combustion control (i.e., low-NO_X burners) and a selective catalytic reduction (SCR) system. Additionally, the existing over-fire air system will be used more aggressively on Big Stone Plant unit I for control of NO_x emissions. As a result, there will be no significant emissions increase in SO_2 or NO_x from the installation of Big Stone II.

Big Stone requests a 12-month rolling plant wide cap of 13,317 tons per year (tpy) of SO_2 and 16,487 tpy of NO_x.

Air Quality Analysis

The existing air quality in the Grant County area is in attainment with the National Ambient Air Quality Standards (NAAQS), or is not classified, for all criteria pollutants. Air dispersion modeling was performed on the pollutants subject to PSD, except VOC, to project the air quality after the new boiler becomes operational. The modeling was performed in accordance with approved EPA modeling guidance and the modeling protocol was submitted to the South Dakota Department of Environment and Natural Resources (SD DENR) on March 25, 2005. The modeling analysis included in Section 6 demonstrates that Big Stone II will not cause or contribute to a violation of the NAAQS or the PSD Increments.

BACT for Coal-Fired Boiler

A "top down" BACT analysis was performed for each of the contaminants in Table ES-2 that were above the PSD significance levels: CO, PM_{10}, VOC, sulfuric acid mist, and fluorides. Pollution control equipment and good combustion practices will ensure that these criteria pollutants meet applicable BACT. A baghouse will control emissions of PM_{10} (including low and semi-volatile metals). Emissions of CO and VOC will be controlled through the use of state-of-the-art boiler equipment and good combustion practices. The use of good combustion practices controls the amount and distribution of excess air in the flue gas to ensure that there is enough oxygen present for complete combustion, thereby minimizing emissions. Optimum boiler maintenance and operating procedures will also be followed. A wet FGD system will be utilized to control sulfuric acid mist emissions and fluoride emissions.

BACT for Other Equipment

A BACT analysis was performed for the diesel generator, fire pump, cooling tower, and materials handling equipment for PM_{10}, CO, VOC, and sulfuric acid mist. BACT for the diesel generator is low-sulfur fuel and good combustion practices. For the emergency diesel fire pump, BACT is determined to be the use of low-sulfur fuels and good combustion practices. BACT for the cooling tower is high efficiency drift eliminators. BACT for the new materials handling operations varies depending upon the type of operation, and consists of baghouse/fabric filters, enclosures and inherent material moisture content.

Table ES-2: BACT Summary.

	Big Stone II		Other Equipment
Pollutant	**Control**	**Rate**	**Control**
CO	Combustion Controls	0.16 lb/MMBtu	Good combustion practices
PM_{10} (filterable and condensable)	Baghouse	0.03 lb/MMBtu	Enclosure, water/surfactant, fabric filter, good work/combustion practices
VOC	Combustion Controls	0.0036 lb/MMBtu	Good combustion practices
H_2SO_4	Wet FGD System	0.005 lb/MMBtu	NA
Fluorides	Wet FGD System	0.0006 lb/MMBtu	NA

Mercury

EPA published the Clean Air Mercury Rule on May 18, 2005 in the *Federal Register*. The rule establishes Standards of Performance for mercury emissions for new and existing electric utility steam generating units. New coal-fired utility units that commence construction after January 30, 2004 are affected by the rules provision. The rule requires subbituminous fired units that use a wet FGD system to achieve a mercury emission rate of 42×10^{-6} lb per megawatt hour or less.

The rule has been challenged by a number of entities and its outcome is uncertain at this time. Big Stone II will conform to the final rule once the regulatory requirements have been defined.

Additional Impacts

The impact of Big Stone II on visibility, soils, and vegetation is discussed in Section 7 of this application. The analysis shows that the new boiler and associated equipment will not have a significant impact on the surrounding area.

1.0 INTRODUCTION

The Big Stone II Co-owners are proposing to construct a new nominal 600 megawatt (MW) [net] pulverized coal-fired boiler, and other equipment associated with the boiler, to meet the increasing capacity and energy requirements for the Co-owners. The Project would be located at the existing Big Stone Plant site, located in Grant County approximately 7.5 miles northeast of Milbank and 2.5 miles northwest of Big Stone City, South Dakota. The existing Big Stone Plant consists of one cyclone-fired coal unit (450 MW).

This application is being made by Otter Tail Power Company on behalf of the Project Co-Owners:

- Central Minnesota Municipal Power Agency (CMMPA);
- Great River Energy (GRE);
- Heartland Consumers Power District (HCPD);
- Montana-Dakota Utilities Co., a Division of MDU Resources Group, Inc. (MDU);
- Otter Tail Corporation dba Otter Tail Power Company (OTP);
- Southern Minnesota Municipal Power Agency (SMMPA); and
- Western Minnesota Municipal Power Agency (WMMPA).

The new boiler will provide steam for a steam turbine generator with a nominal net power output of 600 MW. Actual unit capacity will be determined during detailed design of the plant. On-site construction of Big Stone II is scheduled to begin in spring of 2007, and commercial operation is scheduled for spring 2011. Big Stone II will be classified as a major modification to an existing major source under the Environmental Protection Agency's Prevention of Significant Deterioration (PSD) program. Since the potential to emit for the boiler and associated equipment is greater than PSD major modification significance levels, a PSD review is required. Table 1-1 shows the potential air emissions increase of the proposed construction.

Table 1-1: Emission Estimates for Big Stone II and Associated Equipment

Pollutant	Potential Emissions Increase (TPY)	PSD Significance Level (TPY)
CO	4,262.18	**100**
NO_x	39	40
PM_{10}	932.91	**15**
SO_2	39	40
VOC	106.16	**40**
Lead	0.47	0.6
H_2SO_4	131.40	**7**
Fluorides	15.77	**3**

As can be seen from above table, this project will have a significant emissions increase for PM_{10}, CO, VOC, H_2SO_4, and fluorides.

The purpose of this document is to address the requirements of the PSD program and request issuance of a permit to install the boiler and all supporting equipment at the Big Stone Plant site. The design parameters of Big Stone II are summarized in Table 1-2.

Table 1-2: Expected Design Parameters

Emission Source	Coal-Fired Boiler
Power Output	600 MW of Electricity (nominal net)
Stack Exhaust Temperature	131°F
Operating Hours	Continuous (8,760 hours per year)
Primary Fuel	Subbituminous Coal
Maximum Heat Input	6,000 MMBtu/hr
Startup/Backup Fuel	Fuel oil

The air quality investigation for Big Stone II is divided into the following general parts:

1. A Best Available Control Technology (BACT) demonstration for each pollutant subject to PSD review.
2. An ambient air quality impact assessment to demonstrate that the facility will not exceed the PSD increments and National Ambient Air Quality Standards (NAAQS).
3. An analysis of how the facility will impact commercial/residential growth, soil, vegetation, and visibility in the surrounding area.

The construction permit application is divided into the following sections:

- Section 2 presents a general description of Big Stone II.
- Section 3 provides potential emission estimates of criteria pollutants subject to PSD review.
- Section 4 summarizes federal and state air regulations applicable to Big Stone II, including the PSD permit regulations.
- Section 5 contains the BACT demonstrations. .
- Section 6 provides model descriptions and data requirements for the air quality impact assessment as well as interpretation, analysis, and comparison of the modeling results with applicable air quality regulations.
- Section 7 addresses other air quality-related impacts (i.e., growth, soil, vegetation, and visibility).

The construction permit application forms, required by the DENR are included in Appendix A.

2.0 PROJECT DESCRIPTION

The site proposed by the Big Stone II Co-Owners is an existing industrial site adjacent to the existing Big Stone Plant unit I northwest of Big Stone, South Dakota. The site is located in Grant County, which is currently designated as an attainment/ unclassified area for all criteria pollutants in 40 CFR Part 81. Figure 2-1 shows the location of Big Stone II on a United States Geological Survey (USGS) 7.5-minute map. A scaled layout of Big Stone II, its fence line, and its property boundaries are shown in Appendix B.

Big Stone II plans to install a new coal-fired boiler that will utilize pulverized coal technology to generate steam to power a nominal 600 MW net steam turbine generator. The unit will provide baseload power to the electric grid on a continual basis. Depending on energy requirements, the unit will be operated at full load for the majority of its operating hours. The following equipment will also be installed in conjunction with the coal-fired boiler:

- Low-NO_X burners, over-fire air, and selective catalytic reduction (SCR)
- Baghouse
- Wet flue gas desulfurization (FGD)
- Diesel generator and emergency fire pump
- Coal and combustion by-product handling and storage facilities
- Cooling tower

Combustion controls (i.e., low-NO_X burners and over-fire air) and SCR will be used to control NO_X emissions. A baghouse will be used to control PM_{10} emissions. To minimize the emission of SO_2, a wet FGD will be installed using limestone as the reagent. Good combustion practices will control CO and VOC. The wet FGD system, in conjunction with the baghouse, will be used for the control of acid gases. The baghouse will also control other inorganic Hazardous Air Pollutants (HAPs) (metals).

Figure 2-2 presents an overall process flow diagram for Big Stone II. Figures 2-3, 2-4, 2-5, and 2-6 present diagrams for the bottom ash, fly ash, limestone, and coal handling, respectively.

The flue gas stream passes through the wet FGD system where limestone is added to the gas stream to remove SO_2. Dewatered waste slurry (FGD sludge) from the FGD process is gypsum ($CaSO_4 \bullet 2H_2O$). At present, it is anticipated the gypsum will be disposed of in the on-site landfill. However, in the future the gypsum could potentially be sold and shipped by truck or rail to customers for use as feedstock in the manufacturing of sheetrock or wallboard for buildings. The gypsum material from the dewatering system (vacuum filters) will be mechanically conveyed to a temporary storage area for loading into trucks for transport to disposal at the on-site landfill.

The facility will be supplied with a new backup diesel generator. The backup generator will be capable of safely shutting down the new unit in the event of a plant trip or blackout conditions. It is expected that it will only be operated as required for loss of power at Big Stone II and to confirm reliability of the emergency electrical power system. During normal operation, the intent is that one of the two coal-fired units at Big Stone will remain in operation and be capable of providing start-up power to the second coal-fired unit via the 13.8 kV bus in the substation. The Co-owners intend to have the backup diesel generator available for energy sales purposes. Consequently, application to EPA will be made under the New Unit Exemption requirements of the Acid Rain Program. This generator is expected to operate only routinely for 500 hours or less per year, but will be permitted for 8,760 hours per year.

In addition, a diesel-fired internal combustion engine-driven emergency fire water pump will be installed to serve as a fire-water pump to suppress fires at the site. Big Stone proposes to limit the operation of this unit to 500 hours per year.

With the installation of Big Stone II, the four (4) existing vibrating feeders, 72-inch Conveyor 1, 72-inch Conveyor 2 and 72-inch Tripper Conveyor 3 will be upgraded to increase the coal unloading rate from 3150 tons per hour to 3600 tons per hour. This will allow unit trains to be consistently unloaded in approximately 4 hours. The existing transfer point structure, located adjacent to the existing coal barn storage, will be upgraded to provide the necessary support for the new conveyor upgrades and additions.

The existing emergency stock-out system (telescopic chute at the head-end of Conveyor 2) will be replaced with a new chute, which will feed a new 72-inch Silo Feed Conveyor. The new Silo Feed Conveyor will also be provided with a motorized belt plow to form a new emergency stock-out pile. The new emergency stock-out pile formed at this location will contain approximately 28,000 tons, and will provide coal to the existing reclaim hopper, as well as, to a new reclaim hopper. Coal will be transferred to inactive storage from this location by existing mobile equipment. A new dual reclaim hopper with two

(2) vibrating feeders will be provided (adjacent to the existing reclaim hopper) which will transfer coal from the emergency stock-out pile to a new Crusher House. The inactive storage pile will contain approximately 697,000 tons of coal for Units 1 and 2. In order to provide 4 days live storage for new Big Stone II, three (3) new concrete yard storage silos will be constructed to provide an additional 36,000 tons of dedicated storage. Each yard silo will be 70 feet diameter by approximately 196 feet tall, with a single conical mass flow hopper. Coal will be withdrawn from each yard storage silo by a variable speed belt feeder, and transferred to the new Crusher House via a new 36 inch belt conveyor rated at 725 tph.

New conveyors for Big Stone II will be provided in enclosed (enclosed with corrugated roofing and siding on both sides of the gallery) walk-thru conveyor trusses.

A new Crusher House will receive coal from the Live Storage Silos (or from the reclaim system) and will be a totally enclosed structure. The Crusher House will contain a surge bin, two variable speed belt feeders, two ring granulator crushers and motors and all necessary chute work and gates. Each crushing system will be capable of reducing the received coal to the required size at a rate of 725 tph. Coal from the new Crusher House to Big Stone II will be provided by new dual 36-inch belt conveyors.

A new surge bin will be provided with cut-off gates and two variable speed belt feeders which will feed two silo-transfer cascade conveyors. Each silo transfer cascade conveyor will feed dual en-masse "in-plant" coal silo fill conveyors at the rate of 725 tph. With these additions, the coal will then be transferred to the boiler via an underground/aboveground conveying system.

A new wet cooling tower will also be added to the site to remove excess heat from the steam cycle. Some particulate matter can become entrained in the plumes exiting the cells of the cooling tower. These emissions will be minimized through the use of high efficiency drift eliminators.

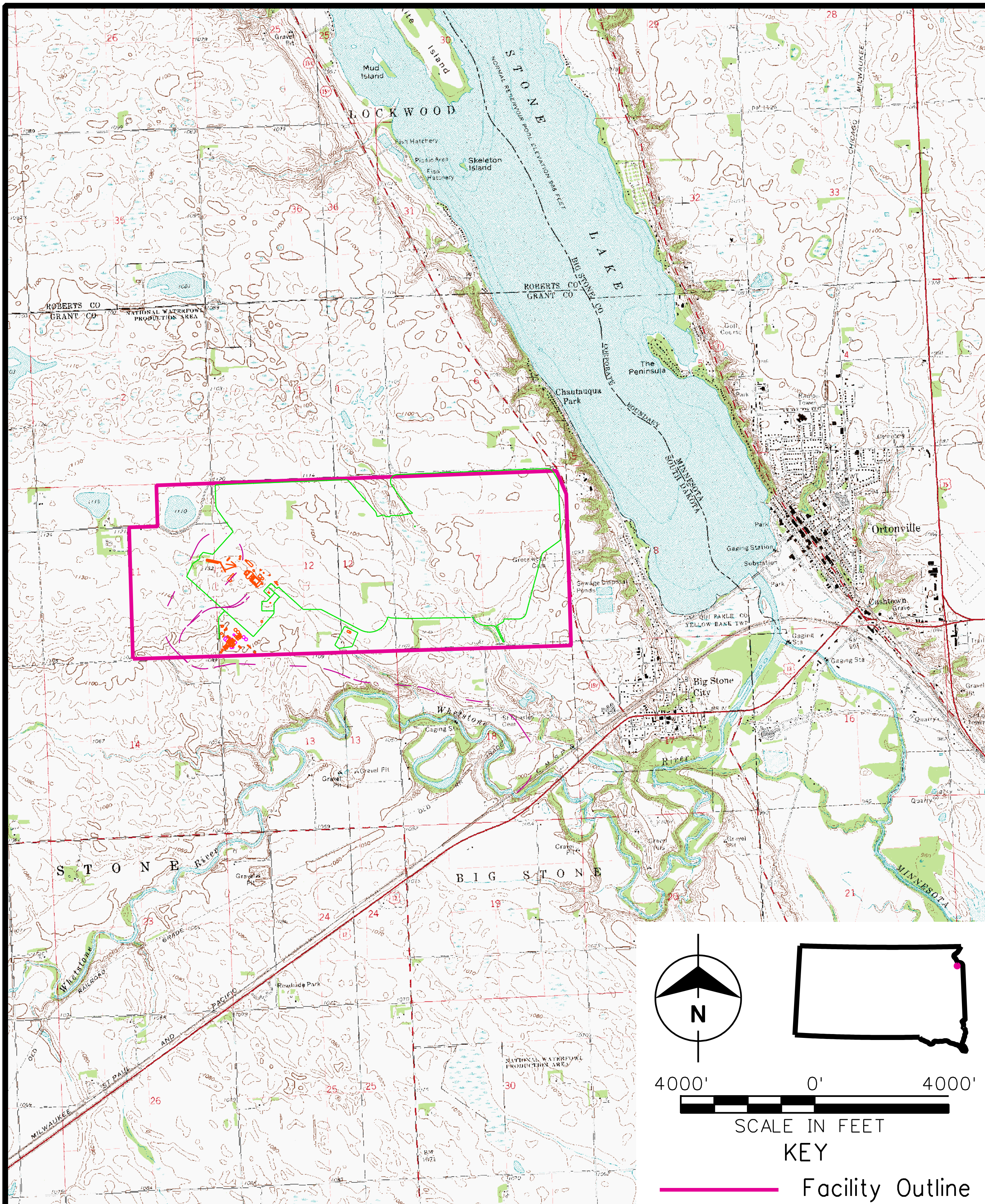
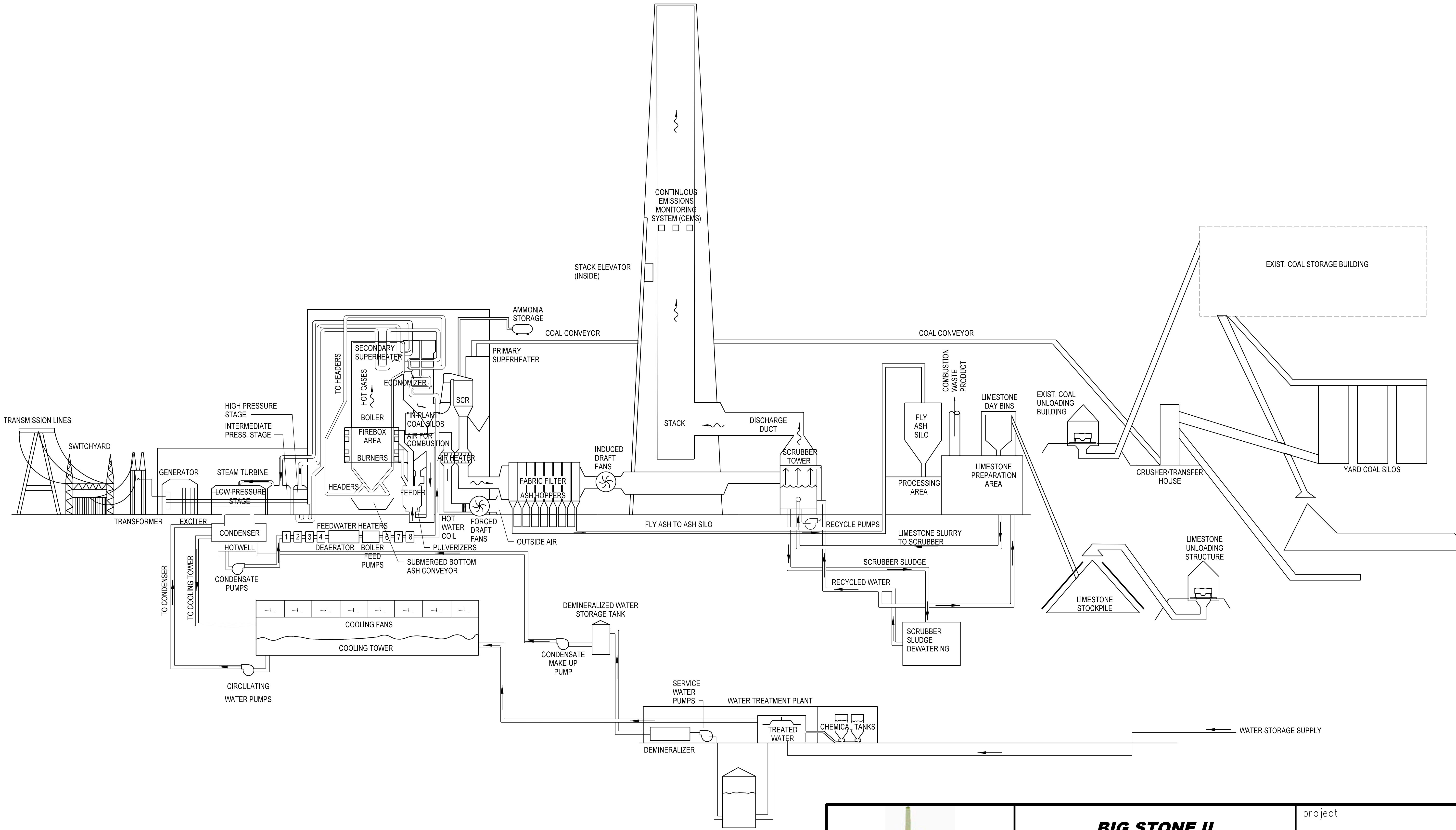


Figure 2-1
Facility Location

USGS Quadrangle Ortonville, MINN 1971
USGS Quadrangle Big Stone Lake SE, S DAK 1971



BIG STONE II
PARTNERS IN GENERATION

BIG STONE II
600 MW-PC

project

contract

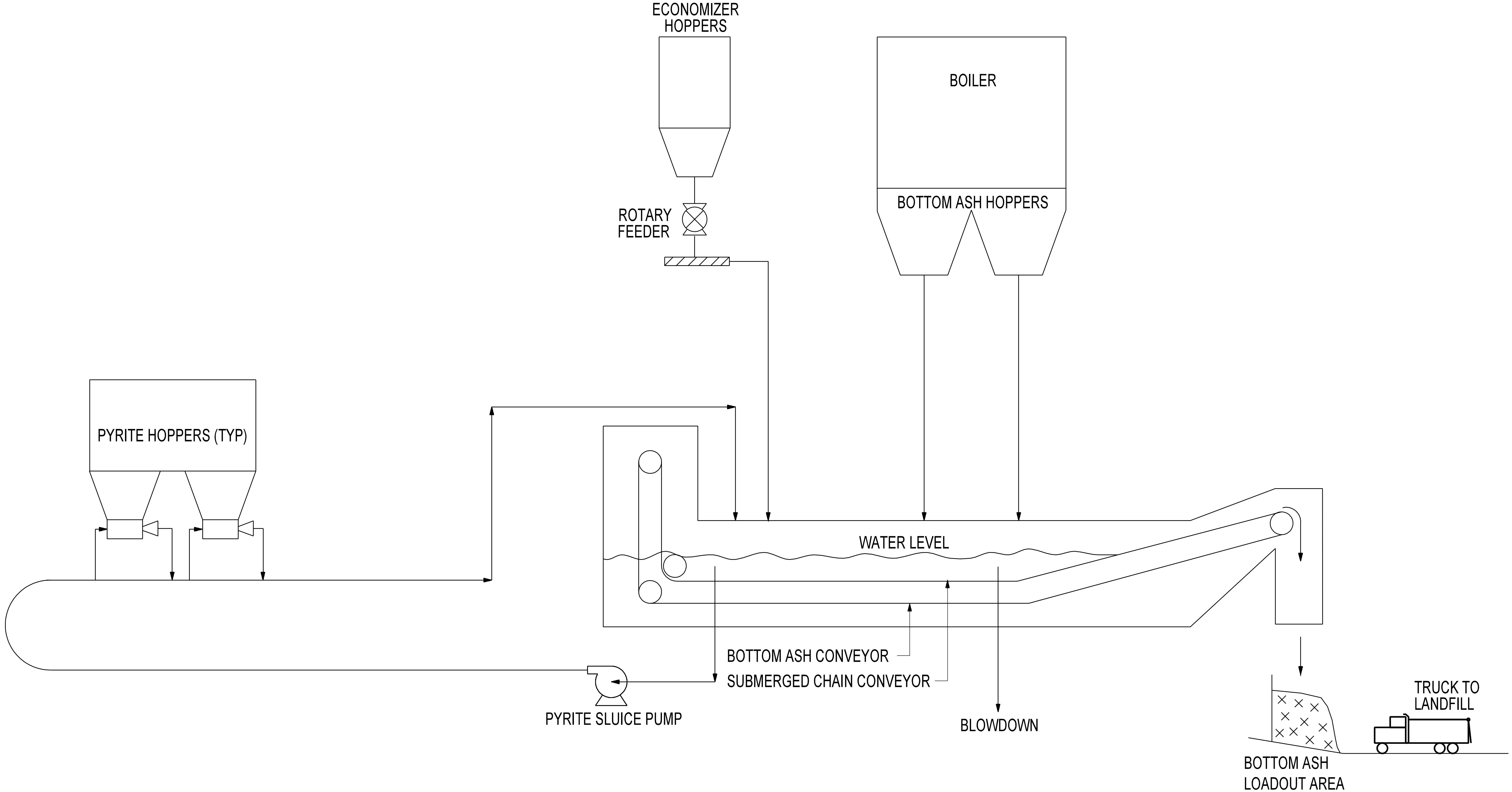
date

designed

OVERALL PROCESS FLOW DIAGRAM

$FILE$

DTI



BIG STONE II
600 MW-PC

BOTTOM ASH HANDLING
FLOW DIAGRAM

project

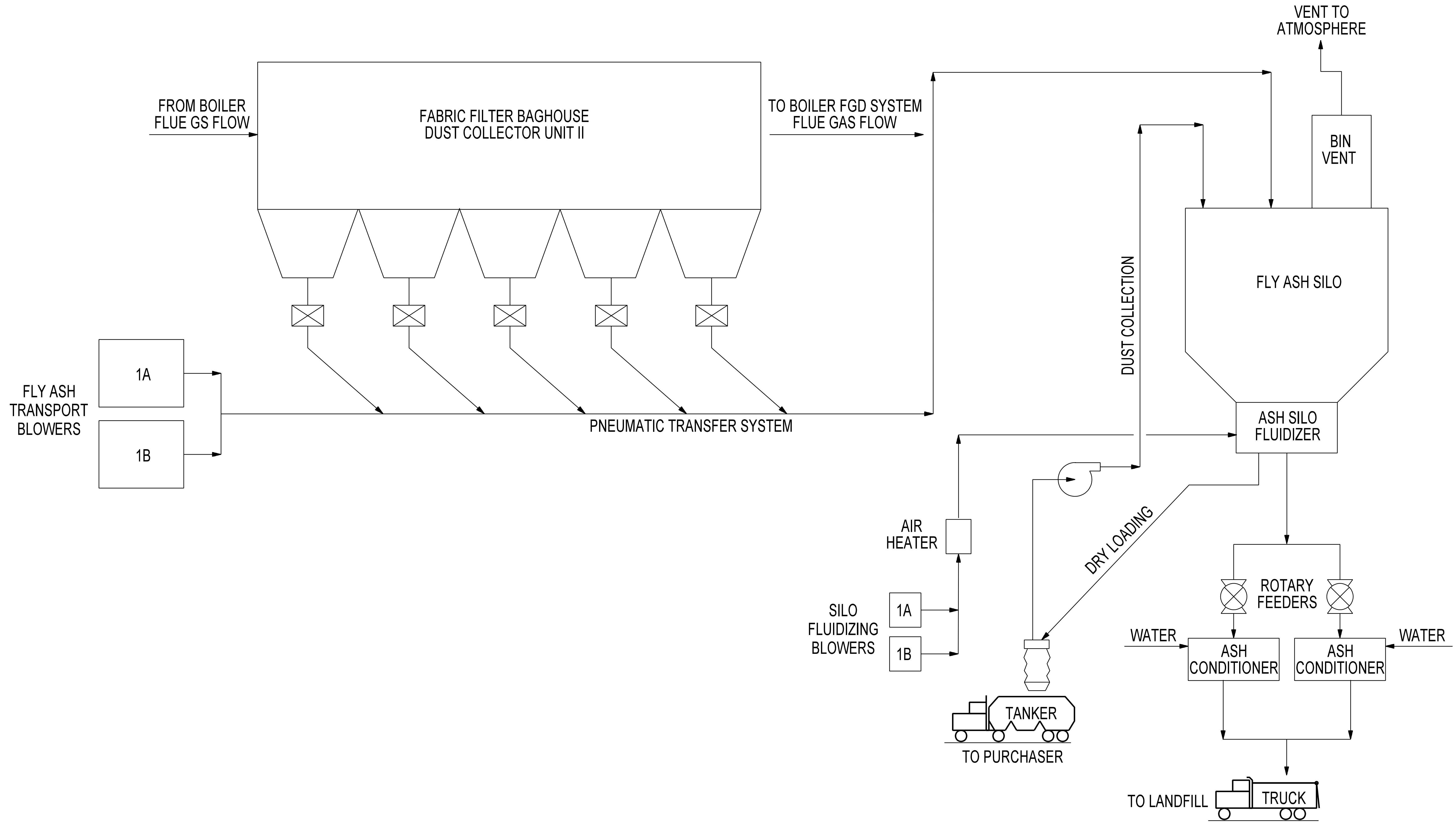
contract

date

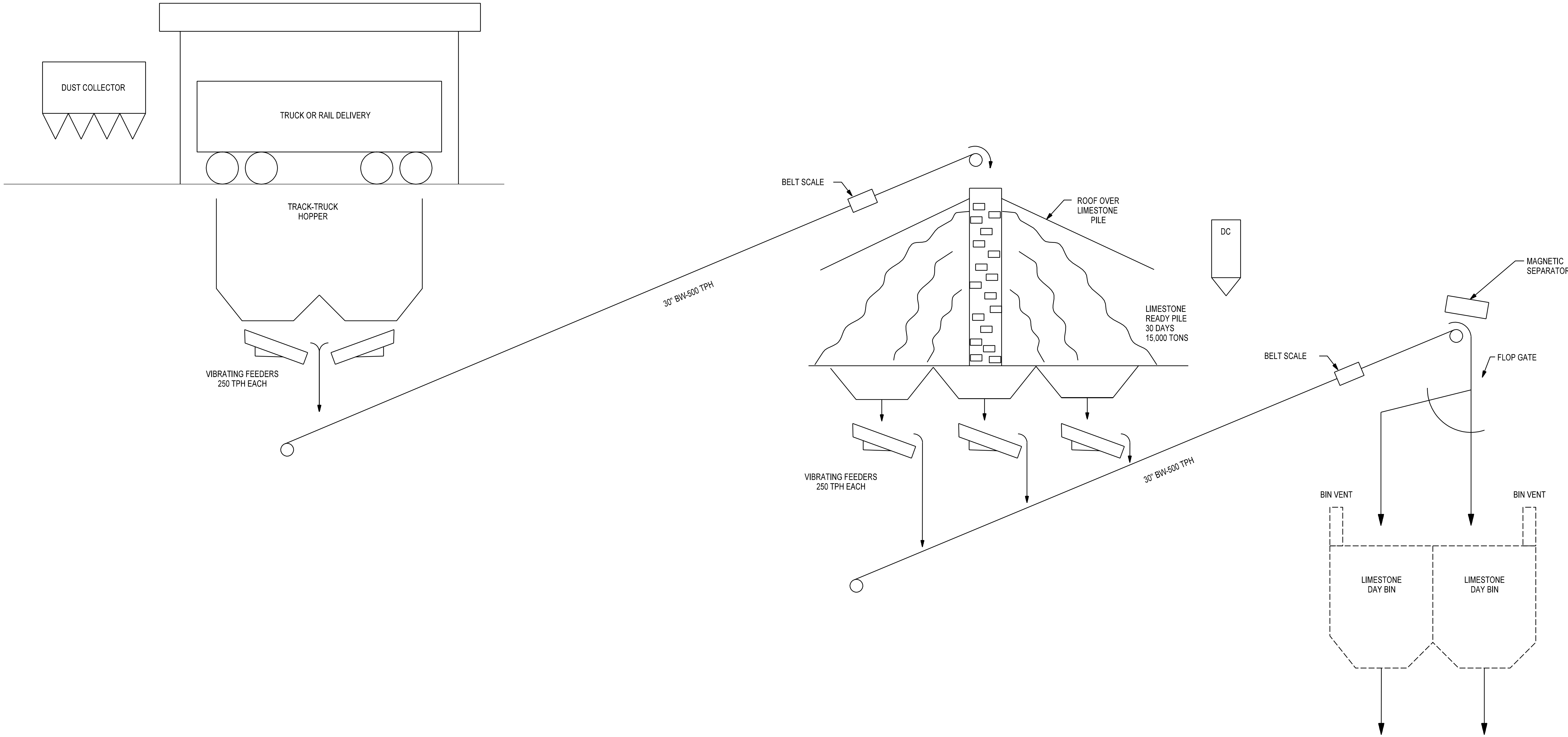
designed

FIGURE 2-3

$FILE$ DTI



Big Stone II	**BIG STONE II** **600 MW-PC**	project
date	FLY ASH HANDLING FLOW DIAGRAM	contract
designed		FIGURE 2-4



BIG STONE II
PARTNERS IN GENERATION

date

designed

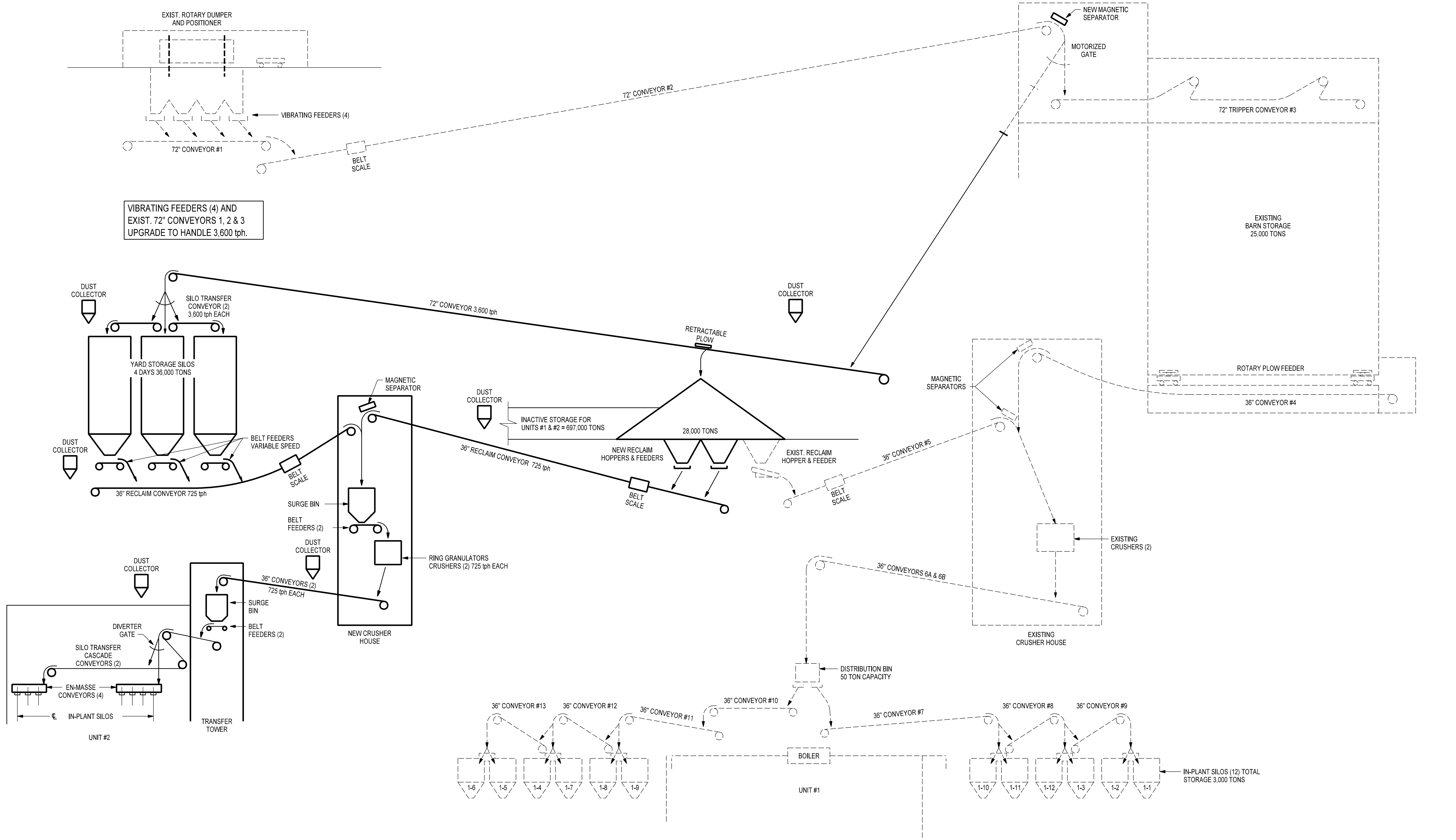
BIG STONE II
600 MW-PC

LIMESTONE HANDLING
FLOW DIAGRAM

project

contract

FIGURE 2-5



BIG STONE II

date

designed

BIG STONE II
600 MW-PC

COAL HANDLING
FLOW DIAGRAM

project

contract

FIGURE 2-6

3.0 EMISSIONS ESTIMATES

New emissions of criteria pollutants will accrue from Big Stone II due to the combustion of coal in the boiler, the transfer of coal and combustion wastes, and auxiliary equipment. The Big Stone II boiler and auxiliary combustion equipment have the potential to emit NO_X, SO_2, CO, VOC, PM_{10}, H_2SO_4, lead, and fluorides while the materials handling systems and cooling tower will potentially emit PM_{10}. Emissions from the boiler are dependent on the unit's operating load. To account for different load scenarios, emissions were analyzed at 25 percent, 50 percent, 75 percent, and full load. Table 3-1 shows the maximum expected potential yearly emission rates from the boiler and the potential yearly emissions from other sources associated with the new boiler.

The following assumptions were used to determine potential annual emissions from the boiler:

- Emissions for the boiler assumed full load for 8,760 hours annually
- CO emissions assumed an emission rate of 0.16 lb/MMBtu
- PM_{10} (filterable and condensable) emissions assumed an emission rate of 0.03 lb/MMBtu
- VOC emissions assumed an emission rate of 0.0036 lb/MMBtu
- H_2SO_4 emissions assumed an emission rate of 0.005 lb/MMBtu
- Lead emissions assumed an emission rate of 1.8 x 10^{-5} lb/MMBtu
- Fluoride emissions assumed an emission rate of 0.0006 lb/MMBtu

Table 3-1: Potential Emissions from Big Stone II and Ancillary Operation

Pollutant	Potential Emissions Increase (TPY)	PSD Significance Level (TPY)
CO	4,262.18	**100**
NO_x	39	40
PM_{10}	932.91	**15**
SO_2	39	40
VOC	106.16	**40**
Lead	0.47	0.6
H_2SO_4	131.40	**7**
Fluorides	15.77	**3**

3.1 Emission Sources

As previously stated, emissions from Big Stone II will originate from the boiler, the cooling tower, auxiliary combustion equipment, and associated material handling systems. Each new emission point is discussed in more detail in the sections below. Control device descriptions, efficiencies and the procedures for estimating emissions, are also discussed below. Tables showing the emission calculations are included in Appendix C.

3.2 Plant Wide Emissions Cap for SO_2 and NO_x

As part of this project, the existing Big Stone Plant unit I flue gas will be ducted to the WFGD system to control SO_2 emissions from the unit. Additionally, over-fire air will be used more aggressively on Big Stone Plant unit I for control of NO_x emissions. As a result, there will be no significant emissions increase in SO_2 or NO_x from the installation of Big Stone II.

Big Stone requests a 12-month rolling plant wide cap of 13,317 tpy of SO_2 and 16,487 tpy of NO_x. This limit is based on the plant wide average emissions of SO_2 and NO_x from 2003 and 2004 plus 39 tons. See Table 3-2.

Table 3-2: Plant Wide Emissions Cap (tpy)

	Year						
	2000	**2001**	**2002**	**2003**	**2004**	**Average 2003/2004**	**Requested Limit**
SO_2 tpy	13,529	13,620	11,759	12,261	14,296	13,278	13,317
NO_x tpy	16,900	16,360	14,857	15,863	17,033	16,448	16,487

3.3 Boiler

One new pulverized coal-fired (PC) boiler will be installed. The boiler will be equipped with low-NO_X burners, over-fire air, and SCR to reduce NO_X emissions, wet FGD to control SO_2 and acid gases, and a baghouse to control PM_{10}. Individual pollutant emission estimates are presented below.

3.3.1 Boiler CO Emissions

The emission rate for CO was assumed to be 0.16 lb/MMBtu based on the BACT analysis. The design heat input to the boiler is expected to be 6,000 MMBtu/hr, resulting in CO emissions as follows:

E_{CO} = (6,000 MMBtu/hr heat input) ∗ (0.16 lb/MMBtu)
= 960 lb/hr
= 4,204.80 tons per year

3.3.2 Boiler PM_{10} Emissions

The emission rate for PM_{10} was assumed to be 0.03 lb/MMBtu (filterable and condensable) based on the BACT analysis. The design heat input to the boiler is expected to be 6,000 MMBtu/hr, resulting in PM_{10} emissions as follows:

E_{PM10} = (6,000 MMBtu/hr heat input) ∗ (0.03 lb/MMBtu)
= 180 lb/hr
= 788.40 tons per year

3.3.3 Boiler VOC Emissions

The emission rate for VOC was assumed to be 0.0036 lb/MMBtu based on the BACT analysis. The design heat input to the boiler is expected to be 6,000 MMBtu/hr, resulting in VOC emissions as follows:

E_{VOC} = (6,000 MMBtu/hr heat input) ∗ (0.0036 lb/MMBtu)
= 21.6 lb/hr
= 94.61 tons per year

3.3.4 Boiler H_2SO_4 Emissions

The emission rate for H_2SO_4 was assumed to be 0.005 lb/MMBtu based on the sulfur content of the coal and the WFGD SO_2 control technology. The design heat input to the boiler is expected to be 6,000 MMBtu/hr, resulting in H_2SO_4 emissions as follows:

E_{H2SO4} = (6,000 MMBtu/hr heat input) ∗ (0.005 lb/MMBtu)
= 30 lb/hr
= 131.4 tons per year[1]

[1] Emissions calculated using *Estimating Sulfuric Acid Aerosol Emissions from Coal-Fired Power Plants* (R. Hardman, R. Stacy, 9/98 Revision). See Appendix C for documentation.

3.3.5 Boiler Lead Emissions

The emission rate for lead was assumed to be 1.8×10^{-5} lb/MMBtu based on the baghouse controls in the BACT analysis. The design heat input to the boiler is expected to be 6,000 MMBtu/hr, resulting in lead emissions as follows:

E_{Pb} = (6,000 MMBtu/hr heat input) * (1.8×10^{-5} lb/MMBtu)
= 0.108 lb/hr
= 0.47 tons per year

3.4 Cooling Tower

A new wet cooling tower is proposed to handle the new steam turbine exhaust heat load. Water from the cooling tower is cycled through the circulating water system to remove heat from the Big Stone II steam turbine exhaust. The makeup water when supplied to the cooling tower contains trace amounts of dissolved minerals. These constituents can become entrained in the cooling tower drift (liquid water droplets carried along with the evaporated water) and be emitted as PM_{10}. The maximum concentration of solids in the water is determined by design limits of the equipment. For purposes of estimating PM_{10} emissions from the cooling tower, a total dissolved solids concentration is assumed to be 6,000 ppm. The high efficiency drift eliminators will control drift to 0.0005 percent, leaving a drift rate of approximately 1.56 gallons of water per minute lost from the cooling tower. An emission rate was calculated as follows:

6,000 ppm = 0.006 pounds of solids per pound of water
(0.006 lb PM / lb water) * (1.56 gpm) * (8.34 lb/gal) = 0.078 pounds per minute PM_{10} emitted
(0.078 lbs/min) * (60 min/hr) = 4.69 pounds per hour of PM_{10} emitted from the new cooling tower
(4.69 lb PM_{10}/hr) * (8,760 hr/yr) / (2000 lbs/ton) = 20.6 tons / year of PM_{10} for new cooling tower

3.5 Auxiliary Combustion Equipment

Emissions from fuel combustion will result from the diesel fire pump and diesel generator. Diesel fuel will be limited to a sulfur content of ≤0.05 percent sulfur.

Fire pump: 525 HP x 0.00205 lb SO_2/hp-hr = 1.08 lb/hr
1.08 lb/hr x 500 hr/yr x ton/2000 lbs = 0.27 tpy

Generator: 2,220 HP x 0.00205 lb SO_2/hp-hr = 4.55 lb/hr
4.55 lb/hr x 8,760 hr/yr x ton/2000 lbs = 19.93 tpy

3.6 Materials Handling Operations

Emissions of PM_{10} result from the transfer and handling of other materials on-site. These materials include the low-sulfur western subbituminous coal, limestone and ash materials. Additionally, the haul roads on-site as well as the storage piles will generate fugitive emissions.

All of these sources were identified in the "Fugitive Emissions Protocol," submitted to DENR on April 29, 2005. That protocol can be found in Appendix E and lists the emission operations and associated controls, as well as the methodology for calculating the emissions.

4.0 REGULATORY REVIEW

Emission sources at Big Stone II are subject to various federal and state air regulations. This part contains a discussion of the applicable requirements of the PSD regulations, applicable New Source Performance Standards (NSPS), and the Administrative Rules of South Dakota (ARSD).

4.1 PSD Regulations

The PSD review is the process of determining whether pre-construction review is required in accordance with 40 CFR 52.21 and ARSD 74:36. The PSD review consists of the following: a case-by-case BACT determination; an ambient air quality analysis to determine if the project will cause or significantly contribute to a violation of the NAAQS or PSD increment; possible ambient air monitoring; an assessment of the effects on visibility, industrial growth, soil, and vegetation; and an opportunity for public comment. Three criteria were evaluated to determine PSD applicability (EPA, 1990):

1) Whether the project is sufficiently large (in terms of its emissions) to be a "major" stationary source or "major" modification.
2) Whether the source is located in a region designated as "attainment" or "unclassified."
3) Whether the pollutants emitted from a major stationary source exceed the significant emission rates defined by 40 CFR 52.21.

Criteria pollutants include NO_X, SO_2, CO, PM_{10}, VOC, and lead. The definition of a major stationary source is given in 40 CFR 52.21. The Big Stone Power Plant is included in the 28 source categories specified in PSD regulations and thus would be considered a major stationary source only if the potential emissions of a PSD pollutant exceed 100 tons per year. The new boiler is expected to emit PSD pollutants in excess of 100 tons per year; thus meeting the first criteria for PSD applicability. The potential increase in emission rates from Big Stone II are specified in the Table 4-1.

Table 4-1: Significant Emission Levels under PSD Regulations.

Pollutant	Potential Emissions Increase (TPY)	PSD Significance Level (TPY)
CO	4,262.18	**100**
NO_x	39	40
PM_{10}	932.91	**15**
SO_2	39	40
VOC	106.16	**40**
Lead	0.47	0.6
H_2SO_4	131.40	**7**
Fluorides	15.77	**3**

At the time of the submittal of this application, no contract has been executed on a specific boiler for Big Stone II. Emissions were estimated using a panel of reference boilers, which have the same physical characteristics as are intended for this project. Detailed calculations of potential emissions are contained in Appendix C. As shown above, Big Stone II is large enough to classify the project as a major stationary source whose emissions are above the PSD significance levels. Therefore, installation of Big Stone II meets the first and third criteria of PSD applicability.

Big Stone II will be located in an attainment/unclassified area for all criteria pollutants and is subject to PSD review rather than non-attainment New Source Review. The project thus meets the second criteria for PSD applicability.

PSD regulations require that the following issues be addressed:

a) The source will meet all emission standards and applicable rules.
b) The source is not expected to cause an exceedance of any NAAQS or PSD increment (see Section 6 for details).
c) The source will not exceed any applicable maximum allowable increase over the PSD baseline concentration in any area.
d) The source will not exceed any emission limits for HAPs.
e) The source has paid any applicable permit fees.

4.2 New Source Performance Standards

Per 40 CFR Part 60 and ARSD 74:36:07:03, Big Stone II will be subject to several New Source Performance Standards (NSPS). The NSPSs are listed below with a description of how Big Stone plans to meet the standards set forth by the regulations.

4.2.1 Subpart Da

Construction and operation of the Big Stone II boiler (S24) is subject to NSPS 40 CFR Part 60 Subpart Da. Subpart Da applies to each electric utility steam generating unit with a heat input of 250 MMBtu/hr or greater. On February 28, 2005, EPA proposed amended emission limits for SO_2, NO_X, and PM. Although the proposal has not been adopted as a final rule, all steam electric generating units that begin construction, modification or reconstruction after February 28, 2005 would be affected by the proposed amendments.

For electric utility steam generating units firing subbituminous coal, the following requirements from amended Subpart Da will apply based on the February 28, 2005 proposal:

1) NO_X performance standards:
   - 1.0 pounds of NO_x per megawatt-hour (lb/MWh) of gross energy output over a 30-day rolling average period.

   The Big Stone II boiler emission rate will be less than 1.0 pounds of NO_X per megawatt-hour (lb/MWh) of gross energy output averaged over a 30-day rolling average period.

2) SO_2 performance standards, averaged over a 30-day period:
   - 2.0 pounds of SO_2 per megawatt hour (lb/MWh) of gross energy output over a 30-day rolling average

   The Big Stone II boiler emission rate will be less than 2.0 pounds of SO_2 per megawatt hour (lb/MWh) of gross energy output averaged over a 30-day rolling average.

3) Total particulate performance standards:
   - 0.015 lb/MMBtu. (filterable particulate only)
   - Opacity shall not exceed 20% on a 6-minute average, except for one 6-minute period per hour not greater than 27% opacity (excluding periods of startup, shutdown, and malfunction).

The Big Stone II boiler emission rate for PM (filterable only) is 0.015 lb/MMBtu. Please note that the PM_{10} limit established in the BACT is 0.03 lb/MMBtu (filterable plus condensables). The Big Stone II boiler will be in compliance with the opacity standards.

4) Mercury performance standards. The following performance standard for mercury emissions was added to Subpart Da on May 18, 2005, and applies to all units constructed after January 30, 2004:

- Subbituminous coal- fired units that use a wet FGD system must achieve a mercury emission rate of 42×10^{-6} lb per megawatt hour or less, based on a 12-month rolling average.

The Big Stone II boiler will be in compliance with the mercury standard.

Subpart Da will require continuous monitoring of the exhaust gas for NO_X, SO_2, mercury, and opacity.

4.2.2 Subpart Y

Subpart Y of the NSPS applies to any of the following affected facilities in coal preparation plants which were constructed or modified after October 24, 1974 and process more than 181 Mg (200 tons) per day: Thermal dryers, pneumatic coal-cleaning equipment (air tables), coal processing and conveying equipment (including breakers and crushers), coal storage systems, and coal transfer and loading systems.

New conveyors and storage systems shall not exhibit 20 percent opacity or greater.

4.3 Internal Combustion Engine NSPS and NESHAP

The diesel generator is subject to the National Emission Standard for Hazardous Air Pollutants (NESHAP) as regulated by 40 CFR Part 63 Subpart ZZZZ. The diesel fire pump is exempt from this NESHAP because its use will delegated to testing and emergency use. The diesel generator will be required to meet NESHAP unless its use is reserved to emergency use only. The Co-owners prefer to defer the decision to a later date.

NESHAP Subpart ZZZZ requires the generator to reduce CO emissions by 70 percent or more, or limit the concentration of formaldehyde in the stationary reciprocating internal combustion engine (RICE) exhaust to 580 parts per billion by dry volume (ppmdv) or less at 15 percent O_2.

The proposed NSPS Subpart IIII - Standards of Performance for Stationary Compression Ignition Internal Combustion Engines was signed June 30, 2005 but has not been published in the Federal Register as of submittal of this application. Therefore, the final rule may differ from the proposed rule. As proposed, the diesel generator and the diesel fire pump emission will be required to meet the NSPS.

This application assumes that the diesel generator will potentially operate for 8,760 hours per year. Table 4-2 compares the emission limitations in NSPS Subpart IIII to the emission rated used for the dispersion modeling. The modeled emission rates are higher than the NSPS Subpart IIII limits for NO_x, HC, and PM_{10}. This allows the model to be conservative in case the facility decides at a future date to limit the generator to emergency use only which would make the unit exempt from NESHAP Subpart ZZZZ. Under the NESHAP exemption for emergency use, the generator unit could emit the emission rates that were modeled.

Table 4-2: Emission Rate Comparison for the Diesel Generator.

Pollutant	NSPS Subpart IIII Emission Rates (gm/hp hr)	Modeled Emission Rates (gm/hp hr)
NO_x + HC*	4.8	9.01
CO	2.6	2.6
PM_{10}	0.15	0.35

*Hydrocarbons

4.4 South Dakota Air Quality Standards and Regulations

This section describes the regulations which apply to Big Stone II, according to the ARSD.

4.4.1 ARSD 74:36:09 - State Origin PSD Review

Under the 1977 Clean Air Act Amendments (CAAA), BACT and other PSD requirements applied to emissions of criteria pollutants and also to emissions of certain non-criteria pollutants regulated under Section 111 (NSPS) and Section 112 (NESHAP) of the Act. However, in Section 112(b)(6) of the 1990 CAAA, Congress specifically excluded the HAPs listed in Section 112(b)(1) from the PSD requirements. U.S. EPA clarified this exclusion in a March 11, 1991 memo from John Seitz. This memo stated that:

> "the following pollutants, which have been regulated under PSD, are now exempt from Federal PSD applicability:
>
> - arsenic
> - asbestos
> - benzene
> - beryllium
> - hydrogen sulfide
> - mercury
> - radionuclides (including radon and polonium)
> - vinyl chloride

4.4.2 ARSD 74:36:05 - Operating Permits

Big Stone Plant unit I has applied for, and received, a Title V operating permit for the existing equipment at the Big Stone Power Plant. Big Stone will apply for an amendment to their Title V permit within 12 months after commencing operation of Big Stone II.

4.4.3 ARSD 74:37:01 - Air Permit, Emission and Inspection Fees

This section describes the fees necessary for submitting a permit to DENR for processing. The application includes the $100 permit application fee as indicated in ARSD 74:37:01

4.4.4 ARSD 74:36:06:02 - Allowable Emissions for Fuel-Burning Units - Particulate Emissions

Big Stone II will be subject to the requirements listed in ARSD 74:36:06:02. According to this rule, a fuel-burning unit with a heat input equal to or greater than 10 MMBtu/hr may not exceed the particulate matter emissions rate determined by the following equation:

$E = 0.811\ H^{-0.131}$, where

E = the allowable particulate emissions rate in lb/MMBtu of heat input and

H = heat input in MMBtu/hr (6,000);

E = 0.259 lb/MMBtu/hr (for Big Stone II)

The Big Stone II boiler emission rate for PM (filterable only) is 0.015 lb/MMBtu. Please note that the PM_{10} limit established in the BACT is 0.03 lb/MMBtu (filterable plus condensables). The unit will therefore be in compliance with this requirement.

The limits for the diesel fire pump and the diesel generator are 0.71 lb/MMBtu and 0.59 lb/MMBtu, respectively. These limits are higher than their corresponding emission rates of 0.43 lb/MMBtu and 0.15 lb/MMBtu, respectively. These rates are approximate since the exact heat rate for the units will not be known until a specific vendor is selected.

4.4.5 ARSD 74:36:06:02 - Allowable Emissions for Fuel-Burning Units - Sulfur Emissions

According to ARSD 74:36:06:02, a fuel-burning unit may not emit sulfur dioxide emissions to the ambient air in an amount greater than three pounds of sulfur dioxide per MMBtu of heat input to the unit based on a three-hour rolling average, which is the arithmetic average of three contiguous one-hour periods. Big Stone II will have an SO_2 emission rate of less than 3 lb/MMBtu and will be in compliance with this regulation.

The diesel fire pump and the diesel generator will burn fuel with a sulfur content ≤ 0.05 percent sulfur, will have an SO_2 emission rate of less than 3 lb/MMBtu, and will be in compliance with this regulation.

4.4.6 ARSD 74:36:12 - Control of Visible Emissions

According to Chapter 74:36:12, of the ARSD, the opacity from the Big Stone II sources must not be greater than 20 percent. The Big Stone II sources will be in compliance with this regulation.

Exceptions are provided for:

- the presence of uncombined water
- smoke is emitted for the purpose of training or research and approved by the department
- For brief periods during such operations as soot blowing, start-up, shut-down, and malfunctions.

4.5 NAAQS

Part 6 of this permit application discusses the ambient air quality analysis and dispersion modeling that was performed for Big Stone II. Big Stone II is not expected to cause or contribute to a violation of the NAAQS. A full description of the NAAQS modeling analysis is included in Part 6.

4.6 Other Ambient Air Quality Standards

In addition to the NAAQS, PSD Class I and II increment consumption must be considered as part of the air quality analysis. There are no Class I areas within 300 km of the Big Stone Power Plant. The impact on visibility in the nearest sensitive area, Pipestone National Monument which is 145 km from the Big Stone Power Plant, was examined. To determine the effect of the plant on this Class II area, VISCREEN modeling was performed. Results of the modeling and a further discussion of the analysis can be found in Part 7.

Additionally, the impact of Big Stone II on soils, vegetation and threatened and endangered species was considered as part of the PSD process. The construction and operation of Big Stone II is not expected to have a detrimental effect on plants, soils or wildlife. A full analysis of these impacts can be found in Part 7 of this report.

4.7 Accidental Release Prevention

The CAA amendments of 1990 included language that requires chemical accident prevention provisions for affected facilities. Section 112(r), Prevention of Accidental Releases, established requirements for owners and operators of stationary sources, who produce, process, handle or store any number of regulated chemicals. The purpose of this requirement is to prevent and mitigate accidental releases of these substances by preparing detailed risk assessment and implementing a number of safety procedures through the preparation of a Risk Management Plan (RMP).

Affected facilities are those stationary sources that store, use, or handle any of the 140 listed hazardous chemicals of flammable/explosive substances in amounts greater than the listed threshold quantities. An analysis will be done after the design is finalized to determine if the generating station will store any of the listed chemicals or substances at quantities near or above the threshold levels. If any chemicals will be stored or handled on-site, Big Stone will comply with the accidental release provisions.

4.8 Monitoring and Compliance

Monitoring and compliance requirements for operation of the coal-fired boiler come from two sources. They are:

- New Source Performance Standards, 40 CFR Part 60, Subpart Da, Standards of Performance for Electric Utility Steam Generating Units
- Continuous Emissions Monitoring, 40 CFR Part 75

In instances where there are multiple requirements it is understood that compliance with the most restrictive requirement will demonstrate compliance with all other requirements.

4.9 Initial Compliance Demonstration

The performance test to demonstrate initial compliance will be conducted within 180 days of initial start up of the boiler or within 60 days after achieving maximum operational capacity. The following tests will be conducted:

- Particulate matter concentration, Reference Method 5 or 5B;
- PM_{10}, Reference Methods 5 or 201A and Method 202, adjusted for bias if necessary as described in Section 5.5;
- Non-methane hydrocarbons, Reference Method 25A and Reference Method 18 (if necessary);
- Carbon monoxide, Reference Method 10; and
- Visible emissions, Reference Method 9.

4.9.1 Continuous Emission Monitor (CEM)

The Big Stone II boiler is subject to the compliance monitoring requirements under the Acid Rain regulations in 40 CFR Part 75 and New Source Performance Standards in accordance with 40 CFR Part 60. The boiler will employ a continuous emission monitoring system (CEMS) in accordance with 40 CFR Part 75 to continuously monitor NO_x, SO_2, opacity, CO_2, and volumetric flow rate. The Big Stone II boiler will also comply with the continuous monitor requirements of the Clean Air Mercury Rule. The test plan will be contained in the Part 75 monitoring plan and certification application that will be submitted within the appropriate time periods. Monitoring required under NSPS is discussed in Section 4.2.

4.9.2 Compliance Assurance Monitoring (CAM)

The U. S. EPA promulgated CAM regulations on October 22, 1997 as 40 CFR Part 64. The regulations require that new major sources (defined in CAM regulations as those whose potential criteria pollutant emissions prior to a control device exceed 100 tons/yr) must have a monitoring plan for each such pollutant. However, the regulation exempts sources subject to certain standards issued after November 15, 1990, acid rain permitted sources, and sources who obtained federally enforceable construction permits containing continuous compliance methods specified in approved SIP regulations.

Since the proposed Big Stone II will be governed by post November 15, 1990 Acid Rain permit requirements and since the PSD permit will also include CEM requirements, CAM plans for SO_2 and NO_x are not required under 40 CFR Part 64. Because no specific control technology is being proposed for CO or VOC the uncontrolled emissions are equal to the controlled emissions and no CAM plan is required.

The following emission points may be subject to CAM for particulate emissions. CAM compliance will be addressed in the Title V operating permit application.

EP13	Emergency Reclaim Hopper
EP14	New Baghouse for Coal Silos #1, 2, and 3 (Load in)
EP15	New Baghouse for Coal Silos #1, 2, and 3 (Load out)
EP16	Limestone Reclaim Conveyor
EP17	Limestone Receiving Hopper
EP18	Plant Transfer/Silo Fill System
EP19	Fly ash silo bin vent
EP22	Transfer from Existing Conveyor 2 to New Silo Feed Conveyor
EP23	New Crusher House
EP24	Big Stone II Boiler

5.0 BEST AVAILABLE CONTROL TECHNOLOGY ANALYSIS

Any proposed construction at a major source having the potential to result in a net increase in emissions of regulated pollutant at levels greater than the corresponding PSD significance levels is subject to PSD review, including a BACT analysis for each of these pollutants. The projected controlled annual emissions and PSD significance levels for Big Stone II are shown in Table 5-1. The potential controlled emissions in Table 5-1 are based on continuous operation for an entire year (8,760 hours) at an assumed Maximum Continuous Rating (MCR) heat input of 6,000 MMBtu/hr, taking into account SO_2 and NO_x reductions from unit I.

Table 5-1: Big Stone II Total Annual Emissions and Significance Levels

Pollutant	Potential Controlled Emissions (tpy)	PSD Significance Level (tpy)	BACT Required
CO	4,262.18	**100**	Yes
NO_x	39[A]	40	No
PM_{10}	932.91	**15**	Yes
SO_2	39[A]	40	No
VOC	106.16	**40**	Yes
Lead	0.47	0.6	No
H_2SO_4	131.40	**7**	Yes
Fluorides	15.77	**3**	Yes

[(A)]Overall netted emissions are based on emission increases (i.e., Big Stone II addition) and decreases (i.e., Big Stone unit I decreases) that will be contemporaneous.

Table 5-1 indicates that the controlled potential to emit for PM_{10}, CO, VOC, sulfuric acid mist, and fluorides are greater than the respective PSD significance level. These five pollutants are subject to BACT review because they exceed the PSD significance levels. Emissions of SO_2 and NO_x are not subject to BACT review. Refer to Section 3.2 for additional information.

A BACT analysis was performed using the "top-down" approach, which is described in the next section. A summary of the proposed emission BACT results is shown in Table 5-2. A more detailed explanation behind the selection of each control technology and emission rate is given in Section 5.3 through 5.9.

Table 5-2: Summary of BACT for Big Stone II

Pollutant	Control Method	Emission Rate lb/MMBtu
PM_{10}	Baghouse	0.03
CO	Combustion Controls	0.16
VOC	Combustion Controls	0.0036
Sulfuric Acid Mist	Wet FGD and Baghouse	0.005
Fluorides	Wet FGD	0.0006

PM_{10}: The greatest degree of particulate control is achieved through the use of baghouses (fabric filters). Therefore, a baghouse capable of controlling emissions to 0.03 lb/MMBtu was selected as BACT for PM_{10}. This limit is for the filterable and condensable portion of PM_{10}, and a description of the methodology used to arrive at this emission limit is included in Section 5.5.

CO and VOC: Combustion controls are the only feasible method available to control CO and VOC emissions for a PC boiler. Combustion controls were selected as BACT for CO and VOC as discussed in Sections 5.6 and 5.7, respectively.

Sulfuric Acid Mist: Wet FGD used in conjunction with a baghouse was selected as BACT for sulfuric acid mist to control emissions to 0.005 lb/MMBtu. Sulfuric acid mist emissions are discussed further in Section 5.8.

Fluorides: The greatest degree of fluoride control is achieved through the use of wet FGD. Therefore, wet FGD to control emissions to 0.0006 lb/MMBtu was selected as BACT for fluorides as discussed in Section 5.9.

5.1 Top-Down Analysis

The Draft 1990 New Source Review Workshop Manual describes the "top-down" BACT process as follows:

> "In brief, the top-down process provides that all available control technologies be ranked in descending order of control effectiveness. The PSD applicant first examines the most stringent--or "top"--alternative. That alternative is established as BACT unless the applicant demonstrates…that technical considerations, or energy, [secondary] environmental, or economic impacts justify a conclusion that the most stringent technology is not "achievable" in that case. If the most stringent technology is eliminated in this fashion, then the next most stringent alternative is considered, and so on."

The 1990 Workshop Manual identifies the basic steps of a top-down BACT analysis as follows:

Step 1 – Identify all control technologies
Step 2 – Eliminate all technically infeasible control technologies
Step 3 – Rank control technologies by control effectiveness
Step 4 – Evaluate most effective controls and document results
Step 5 – Select BACT

The EPA has consistently interpreted the statutory and regulatory BACT definitions as containing two core requirements that EPA believes must be met by any BACT determination. First, the BACT analysis must include consideration of the most stringent available technologies: i.e., those that provide the "maximum degree of emissions reduction." Second, any decisions to require a lesser degree of emissions reduction must be justified by an objective analysis of "energy, environmental, and economic impacts" contained in the record or the permit decisions (EPA, 1990).

The minimum BACT emission rate must be at least as restrictive as the NSPS, if such standard applies. As discussed in Part 4, the construction of Big Stone II is subject to 40 CFR 60, Subpart Da, "Standards of Performance for Electric Steam Generation Units for which Construction Commenced after September 18, 1978." This NSPS currently limits the total filterable particulate emissions to 0.03 lb/MMBtu; however, a reduction of the NSPS limit to 0.015 lb/MMBtu has been proposed by the EPA (70 FR 9705). If adopted, the revised emission rate would be applicable to all Subpart Da sources that commenced construction after February 28, 2005.

The BACT analysis evaluates control technologies for individual pollutants, but in the final analysis the control equipment has to be evaluated as an integrated air pollution control system. The control technologies are interdependent, and reducing emissions for one pollutant may result in adverse impacts and higher emissions of another pollutant. As one example, some technologies that reduce NO_X emissions will unavoidably result in higher CO and VOC emissions due to reaction kinetics. The best overall air pollution control system utilizes the mix of control technologies that yields the optimal overall performance and lowest overall emission levels.

5.2 Identification of Control Options

Several sources were reviewed to determine the control technologies and emission limits that were consistent with BACT. EPA's RACT/BACT/LAER Clearinghouse (RBLC) database was the first reference queried. Other sources of information were EPA's National Coal-Fired Utility Projects Spreadsheet and industry knowledge of other projects that are being developed or constructed. Tables 5-3 and 5-4 list the emission limits (and the associated control technologies) established as BACT for pulverized coal units that have been permitted in the last 15 years.

5.2.1 RBLC Database

One of the best ways to identify available control technologies is to review previous BACT determinations for similar sources. The RBLC database was reviewed to identify recent BACT determinations for similar projects. This database is maintained on EPA's Technology Transfer Network website on the Internet at www.epa.gov/ttn/catc. Advanced queries of the database were conducted to identify control technology determinations previously made for sources similar to Big Stone II. These queries were conducted for RBLC permits issued from January 1990 to May 2005.

Although a specific boiler manufacturer has not been selected, the technology will be super-critical pulverized coal-firing. Therefore, only prior BACT determinations for PC boilers were included in the comparative analysis.

There are approximately 30 PC facilities identified in the RBLC that have been permitted since January 1990. Specific facility and emissions data is listed in Appendix D. Table 5-3 provides a summary of the range of emission limitations identified in the RBLC as BACT for comparable boiler facilities for each pollutant, and the control technology associated with the BACT limits.

Table 5-3: BACT Determinations for Pulverized Coal-Fired Boilers

Pollutant	Emission Limit (lb/MMBtu)	Control Technology Description Associated with BACT Emission Limit	Number of Occurrences
PM_{10}[1]	0.012 – 0.015	Baghouse	4
	0.018 – 0.03	Baghouse	25
	0.018 – 0.023	Electrostatic Precipitator (ESP)	7
CO	0.1 – 0.11	Combustion Control	9
	0.15 – 0.20	Combustion Control	28
VOC	0.0024 – 0.004	Combustion Control	17
	0.01 – 0.067	Combustion Control	20
H_2SO_4 Mist	0.00036 – 0.011	Dry FGD	11
	0.005 – 0.04	Wet FGD w/ or w/o Wet ESP	2
Fluorides	0.0004 – 0.01	Dry FGD	9
	0.000159 – 0.01	Wet FGD	5

[1]Some of the PM_{10} limits include the condensable fraction of PM_{10} and some do not. Table D-1 includes a unit by unit breakdown indicting the basis behind the permit limit (filterable only or filterable plus condensable).

5.2.2 Sources Other Than RLBC Database

In addition to reviewing RBLC for permitted units, other information sources were reviewed to determine current control technologies and emission rates for sources that are comparable to Big Stone II. One source was the National Coal-Fired Utility Projects Spreadsheet, which shows current new project activity as reported by the ten EPA regions. This source identified several PC fired facilities that had obtained a final permit but were not already included in the RBLC. Another information source was an industry review of pulverized coal units that are currently being developed or constructed. Specific facility and emissions data for the units identified in these searches are shown in Appendix D.

Table 5-4 summarizes the emission rate ranges and respective control technologies for the facilities identified by the non-RLBC reviews and searches. The emissions rates are based on emission rates stated in the permit.

Table 5-4: Permitted Rates for PC Boilers not included in the RLBC Database

Pollutant	Emission Limit (lbs/MMBtu)	Control Technology Description Associated with Emission Limit	Number of Occurrences[A]
PM_{10}	0.018	Baghouse	3
	0.015	Multiclone/Venturi Scrubber	1
	0.02 – 0.035	Electrostatic Precipitator (ESP)	3
CO	0.11 – 0.20	Combustion Controls	7
VOC	0.0034 – 0.0065	Combustion Controls	7
H_2SO_4 Mist	0.0046 – 0.01	Wet FGD	6
Fluorides	0.00001 – 0.00088	Wet FGD	6

Notes: A. Emissions rate data for Springerville (Nat. Coal-fired Utility Spreadsheet) not included because they are generally not based on BACT.

The review of the RBLC and other data sources confirmed that control equipment on pulverized coal units has been limited to a few types. Baghouses and electrostatic precipitators have both been used to control particulate and sulfuric acid mist from coal-fired boilers. Wet FGD or dry FGD have been used to control acid gases. No technology other than "combustion control" has been identified as BACT for CO or VOC emissions.

5.3 Coal-Fired PC Boiler: Nitrogen Oxides

Emissions netting is a term that refers to the process of considering certain previous and prospective federally enforceable emissions changes at an existing major source to determine if a "net emissions increase" of a pollutant will result from a proposed physical change or change in method of operation. If the net emission change is less than the Significant Emission Rate (SER), then the modification has "netted out" for that pollutant. Such pollutants are not subject to PSD review, which includes a BACT analysis and modeling.

The netting analysis for Big Stone II showed that net NO_x emission increases from the new generation unit would not exceed the PSD significance level. Therefore, NO_x emissions from the new unit are not subject to PSD requirements such as BACT review. Refer to Section 3.2.

5.4 Coal-Fired PC Boiler: Sulfur Dioxide

The netting analysis for Big Stone II has shown that net SO_2 emission increases from the new generation unit would not exceed the PSD significance level for SO_2. Therefore, SO_2 emissions from the new unit are not subject to PSD requirements such as BACT review. Refer to Section 3.2.

5.5 Coal-Fired PC Boiler: Particulate Matter / PM_{10}

PM_{10} emissions consist of "filterable" PM_{10} and "condensable" PM_{10}. Filterable PM_{10} consists of solid particles that can be collected on a filter media. Condensable PM_{10} is material that is vapor phase at stack conditions, but which condenses and/or reacts upon cooling and dilution in the ambient air to form solid or liquid PM immediately after discharge from the stack (i.e., in the stack plume). Historically, PM_{10} permit limits have generally focused on filterable emissions. However, some of the more recent permits have grouped the filterable and condensable particulate emissions under one PM_{10} emission limit.

There is an increasing concern regarding the ability to reliably measure condensable PM_{10} emissions. Method 202, the EPA test method used to determine condensable PM_{10}, has the potential to overestimate the emissions of this pollutant due to measurement of "artifact" contributions of SO_2 and NH_3 that react in the testing apparatus (to create ammonia salts) to give false indications of additional condensable PM_{10}.[2] A more significant issue for Powder River Basin (PRB) coal-fired units is that very little data exists to indicate these expected levels of condensable particulate emissions.

Although the use of the "nitrogen purge" as an optional procedure is allowed under Method 202, it may not adequately account for "artifacts" being created in the test methods. A controlled condensation system may help address this issue, however it is not part of the test method at this time. Conditional Test Method 039 has also been proposed by other utilities as a partial solution to the artifacts issue. Measurement and subtraction of ammonium chloride and ammonium sulfates from the sample could also aid in eliminating artifact error.

The Co-owners request that DENR acknowledge the artifact error and provide the Co-owners an opportunity to propose a solution to the artifact problem once testing of Big Stone II is required.

5.5.1 Evaluation of Control Options

Filterable particulate emissions from coal-fired combustion sources are generally controlled using either a fabric filter (also called baghouse) or an electrostatic precipitator (ESP). Both of these technologies are mature technologies that are available from a number of suppliers. There are other technologies that have not been permitted as BACT but have been retrofitted into existing facilities. For example, the Advanced Hybrid particulate collector is currently being utilized at Big Stone Plant unit I. It is a technology that is in the development stage as a part of the Department of Energy National Energy Technology

[2] Louis A. Corio and John Sherwell, "In-Stack Condensible Particulate Matter Measurements and Issues", Journal of Air & Waste Management Association, Feb. 2000.

Laboratory's Power Plant Improvement Initiative. The Advanced Hybrid is a combination of an ESP and a baghouse. The initial collection mechanism of the Advanced Hybrid consists of an "ESP" while the final collection mechanism is a "baghouse." The device is configured with rows of fabric filter bags located between perforated ESP collector plates, and is equipped with baffles to ensure that all the flue gas passes past and through the collector plates prior to entering the fabric filter bags. The Advanced Hybrid has only been applied full scale as a conversion of the original ESP at Big Stone unit I and has never been installed on a new source. Although the Advanced Hybrid is technically available, the technology is in the development stage.

In the last 20 years, baghouses have become widely accepted for particulate control on low-sulfur coal-fired boilers. Western subbituminous coal has high ash resistivity, which makes particulate collection more difficult in an ESP than for a baghouse. Therefore, the use of a fabric filter is the most effective means of controlling filterable particulate emissions from Big Stone II, and has been selected as the BACT control technique. The condensable portion of the emissions is controlled through wet scrubbing in an FGD system.

Table 5-3 illustrates that the majority of the coal-fired units use fabric filters rather than ESPs for PM_{10} control. As shown on Table D-1, the units utilizing fabric filters are also typically permitted with lower emission rates than those units utilizing ESPs.

5.5.2 Environmental Considerations

There are no environmental issues that would preclude the use of an ESP or baghouse on Big Stone II. However, a baghouse may be beneficial in meeting the mercury emission limitation defined by the EPA's Clean Air Mercury Rule.

5.5.3 Energy Considerations

There are no energy considerations that would preclude the selection of either ESP or baghouse as BACT for Big Stone II.

5.5.4 Economic Considerations

There are no economic considerations that would preclude the selection of either ESP or baghouse as BACT for Big Stone II.

5.5.5 PM_{10} BACT Determination

Baghouses limiting total PM_{10} emissions to 0.03 lb/MMBtu have been selected as BACT for Big Stone II. This emission limit is comparable with the PM_{10} limit (filterable plus condensable) for similar units that have been recently permitted. Installation of the baghouses will result in the lowest particulate emissions from Big Stone II. No other proven particulate control technology is available for the units that would achieve lower emission rates. Compliance with the BACT limit for total PM_{10} will be verified by reference method tests that have been adapted to prevent positive bias from artifact compounds that form in the testing apparatus. The averaging time for the emission limit will correspond to the time required to conduct a test using the test method (approximately 3 hours).

5.6 Coal-Fired PC Boiler: Carbon Monoxide

5.6.1 Evaluation of Control Options

The only method identified to practically control CO emissions from a coal-fired boiler entails the use of appropriate combustion control techniques. The RBLC database and EPA's National Coal-Fired Utility Projects Spreadsheet list no other CO control techniques for pulverized coal units.

CO emissions are the result of incomplete combustion. Operating with higher flame temperatures and longer furnace residence times can reduce CO emissions. Unfortunately, reducing CO emissions in this manner results in an increase of NO_X emissions. Balancing low CO and NO_X emissions is an appropriate consideration in the boiler design and operation. Generally, reducing NO_x emissions is considered to be more important than achieving lower CO emissions.

Control technologies such as CO catalysts are not currently available for use on a solid-fuel fired boiler. Catalytic reduction for CO is not technically feasible because ash in the gas stream would destroy the catalyst after a very short period of operation, resulting in extremely high operational and maintenance costs due to the frequent catalyst replacement.

5.6.2 Environmental Considerations

Environmental impacts are a consideration in the determination of BACT for CO. Operating the boiler to achieve lower CO emissions will result in higher NO_X emissions. Generally, reducing NO_X emissions is considered to be more important than achieving lower CO emissions.

5.6.3 Energy Considerations

There are no significant energy impacts to be considered in the BACT evaluation for CO controls.

5.6.4 Economic Considerations

As previously stated, there is no technically feasible alternative to combustion controls for reduction of CO emissions from a coal-fired boiler.

5.6.5 CO BACT Determination

Combustion controls to achieve CO emissions of 0.16 lb/MMBtu was selected as BACT for Big Stone II. Compliance with the BACT limit will be verified by reference method tests using EPA Method 10. The averaging time for the emission limit will correspond to the time required to conduct a test using the test method (approximately 3 hours).

5.7 Coal-Fired PC Boiler: Volatile Organic Compounds

5.7.1 Evaluation of Control Options

Combustion controls are the only method identified to control VOC emissions from a PC-fired boiler. Similar to CO, however, reducing VOC emissions results in higher NO_X emissions. Consequently, NO_X emissions are an environmental factor in establishing BACT for VOCs.

5.7.2 Environmental Considerations

Environmental impacts are a consideration in the determination of BACT for VOC. Operating the boiler to achieve lower VOC emissions will result in higher NO_X emissions. Generally, reducing NO_X emissions is considered to be more important than achieving lower VOC emissions.

5.7.3 Energy Considerations

There are no energy considerations that would preclude the selection of combustion controls as BACT for Big Stone II.

5.7.4 Economic Considerations

There are no economic considerations that would preclude the selection of combustion controls as BACT for Big Stone II.

5.7.5 VOC BACT Determination

An emission rate of 0.0036 lb/MMBtu using combustion controls is recommended as BACT for VOC emissions. Compliance with the BACT limit will be verified by reference method tests using EPA

Method 25. The averaging time for the emission limit will correspond to the time required to conduct a test using the test method (approximately 3-hours). An emission rate of 0.0036 lb/MMBtu is one of the lowest levels permitted for similar applications. It should be noted that the boiler manufacturer has not been selected, thus any further refinement of the VOC emission limit attainable for Big Stone II is not possible.

5.8 Coal-Fired PC Boiler: Sulfuric Acid Mist

The majority of the sulfur in a coal-fired boiler leaves the boiler as sulfur dioxide. A small percentage of the sulfur oxides leaving a boiler will be sulfur trioxide (SO_3). In addition, the flue gas passing through the catalyst bed of an SCR system results in more of the SO_2 in the flue gas being oxidized to SO_3. As the temperature of the flue gas decreases (when it passes through the economizer, SCR, and air heater), the SO_3 combines with water vapor to form H_2SO_4 vapor. Further decrease of the flue gas temperature (below the acid dew point) results in H_2SO_4 vapor condensing to an aerosol (sulfuric acid mist).

Since Big Stone II will fire a low sulfur subbituminous coal, the quantity of sulfuric acid mist formed will be lower than that produced by a similar unit firing bituminous coal.

5.8.1 Evaluation of Control Options

H_2SO_4 vapor tends to absorb on fly ash in the flue gas as it cools. Consequently, H_2SO_4 can be removed by removing particulate from the gas stream. A baghouse will be much more effective than an electrostatic precipitator at collecting the H_2SO_4. This is because the cake on the baghouse bags tends to act as a barrier. The H_2SO_4 vapor must pass through this barrier which enhances the adsorption of the vapor on the fly ash. The baghouse is expected to remove 90 percent of the H_2SO_4 from the gas stream of a pulverized PRB coal-fired unit.

Additional H_2SO_4 removal also occurs in the scrubber portion of the FGD system. Based on a paper by Southern Company entitled, “Estimating Total Sulfuric Acid Emissions form Coal-Fired Power Plants,” a wet FGD system can be expected to further reduce sulfuric acid mist emissions by approximately 50 percent.[3] Based on the same paper, it is estimated that the total H_2SO_4 reduction across a baghouse/wet FGD combination would be 95 percent.

[3] Keith Harrison and Larry Monroe, “Estimating Total Sulfuric Acid Emissions from Coal-Fired Power Plants” Southern Company Services, Sept. 1998.

Other control options for H_2SO_4 include sorbent injection and the use of a wet electrostatic precipitator.

When sorbent injection is used for H_2SO_4 control, the most common configuration is the injection of lime (CaO) into the flue gas upstream of the particulate collector. However, in the case of PRB coal firing such as at Big Stone II, the fly ash is already highly enriched in CaO. Thus the use of a baghouse for particulate control on a PRB coal-fired boiler effectively uses the same H_2SO_4 control mechanism as the sorbent injection control option. For this reason there are no examples in the industry for which sorbent injection has been used for H_2SO_4 control on a PRB coal-fired boiler.

A wet ESP is an available control option for H_2SO_4 control. Wet ESPs have previously been identified as BACT for H_2SO_4 in several cases, as shown in Tables D-5 through D-7. However, all these cases involved boilers firing high sulfur bituminous coal. No previous examples of the application of wet ESPs for H_2SO_4 control on a unit firing low sulfur coal exist.

Therefore, the combination of low-sulfur coal, a fabric filter baghouse and a wet FGD system has been selected as BACT control technology option for H_2SO_4 control.

5.8.2 Environmental Considerations

There are no additional environmental considerations for the use of a baghouse and a wet FGD to control sulfuric acid emissions as these technologies are already proposed to control particulate emissions and SO_2 emissions from Big Stone II.

5.8.3 Energy Considerations

There are no additional energy considerations for the use of a baghouse and a wet FGD to control sulfuric acid emissions as these technologies are already proposed to control particulate emissions and SO_2 emissions from Big Stone II.

5.8.4 Economic Considerations

There are no additional economic considerations for the use of a baghouse and a wet FGD to control sulfuric acid emissions as these technologies are already proposed to control particulate emissions and SO_2 emissions from Big Stone II. Although technically feasible, the addition of a wet ESP after the wet FGD for additional H_2SO_4 control would be very expensive, representing an increase of approximately 25 to 30 percent in the installed cost of the wet FGD. Due to the extremely low inlet concentrations of H_2SO_4 it would be unlikely that vendor guarantees for significant additional H_2SO_4 removal could be obtained. Furthermore, because the baghouse/wet FGD combination is expected to achieve 95 percent H_2SO_4 control, the additional cost for the small increment of H_2SO_4 control provided by the wet ESP would not be cost effective on a $/ton H_2SO_4 removed basis.

5.8.5 Sulfuric Acid Mist BACT Determination

A fabric filter followed by a wet FGD limiting sulfuric acid mist emissions to 0.005 lb/MMBtu has been selected as BACT for Big Stone II. This emission limit is consistent with sulfuric acid mist limits from recently permitted units. Compliance with the BACT limit for sulfuric acid mist will be verified by EPA Method 8 or by the controlled condensate test method (ASTM D3266) The averaging time for the emission limit will correspond to the time required to conduct a test using the test method (approximately 3 hours).

5.9 Coal-Fired PC Boiler: Fluorides

5.9.1 Evaluation of Control Options

The combustion of coal results in the formation of hydrogen fluoride gas (HF) and other fluoride compounds (to a much smaller degree). HF is water soluble and can be controlled to a high level with a dry FGD/baghouse system or wet FGD system. Both types of FGD systems can remove HF at 90 percent and greater efficiency, with neither type offering a definite control advantage with respect to the other type. The technology identified to have the greatest potential to limit fluoride (hydrogen fluoride) emissions from Big Stone II is a wet FGD. This technology was also selected to control SO_2. There is no environmental, energy, or economic considerations that would preclude the use of a wet FGD for fluoride emission control at Big Stone II.

5.9.2 Environmental Considerations

There are no additional environmental considerations for the use of a wet FGD to control fluoride emissions as this technology is already proposed to control SO_2 emissions from Big Stone II.

5.9.3 Energy Considerations

There are no additional energy considerations for the use of a wet FGD to control fluoride emissions as this technology is already proposed to control SO_2 emissions from Big Stone II.

5.9.4 Economic Considerations

There are no additional economic considerations for the use of a wet FGD to control fluoride emissions as this technology is already proposed to control SO_2 emissions from Big Stone II.

5.9.5 Fluoride BACT Determination

Wet FGD limiting fluorides to 0.0006 lb/MMBtu has been selected as BACT for Big Stone II. This emission limit is consistent with fluoride emission limits from units in the RBLC that have fluoride emission limits (refer to RBLC fluoride summary table). Wet FGD will result in the lowest fluoride emissions from Big Stone II. No other control technology is available for the unit that would achieve lower emission rates. Compliance with the BACT limit for fluorides will be verified by reference method tests using EPA Method 13. The averaging time for the emission limit will correspond to the time required to conduct a test using the test method (approximately 3 hours).

5.10 Material Handling Equipment

5.10.1 Coal Handling Equipment

The coal handling equipment includes the railcar unloading system, transfer towers, the coal unloading system to the storage pile, the underground coal reclaim system from the storage pile, and the plant coal silo fill. For many of the transfer points, the emissions can be enclosed. This allows for mechanical collection of the material and subsequent removal from the exhaust gas stream. Baghouses have the highest control efficiencies of any particulate matter control option and, according to the "top-down" approach, must be considered first. The industry "standard" for baghouse outlet emission rates is 0.01 grains per dry standard cubic foot (gr/dscf). This emission rate is well in excess of 99.9 percent particulate removal efficiency for particles larger than 3 microns.

Rail car unloading will be performed by the existing rotary car dumper, where the existing baghouse will control the dust. Coal from the dumper will be discharged onto a belt conveyor that moves it either to the coal storage pile where it is discharged via telescopic chute or directly to the storage silos. The chute is fitted with a wet spray header to help minimize dusting during the stock out process.

Coal reclaimed from the storage area will be conveyed to a crusher house and then to the en-masse (drag) conveyors that operate at the top of the plant coal silos. Baghouses will collect coal dust at the transfer towers, crusher house, and top of the coal silos.

An examination of the different types of bags available for the baghouses was performed. Dust generated from the transportation and handling of raw coal tends towards larger particle sizes. Consequently, baghouses achieve a high degree of control of raw coal dust. After review of different baghouse vendors and equipment suppliers, it was determined that the coal handling baghouses should be able to achieve a particulate emission rate of 0.01 gr/dscf at the baghouse outlet. As such, all baghouses used to control particulate emissions from the transportation and handling of coal will achieve an outlet emission rate of 0.01 gr/dscf.

As an alternative, passive dust control systems will be provided with Discrete Element Modeled (DEM) transfer chutes. The DEM design will simulate and predict material flow and behavior during the system design process. Baghouse or the passive dust control system (either separately or in combination) will be provided at the following locations:

- Live Storage Silos & Reclaim System
- Crusher House
- Plant Transfer Tower and Silo Fill System

5.10.2 Limestone Handling Equipment

Limestone will be used as a reagent in the wet FGD system for Big Stone II. Limestone handling, storage and preparation equipment will be needed to supply the limestone to the FGD system. Limestone deliveries to the plant are anticipated to be by rail. The limestone will be mechanically conveyed to a covered limestone storage pile. Particulate matter emissions from limestone handling operations will be controlled through baghouses, yielding the highest level of emission control.

As with coal dust, an examination of the different types of bags available for the baghouses was performed. Dust generated from the transportation and handling of lime tends toward larger particle sizes, similar to that for coal dust. After review of different baghouse vendors and equipment suppliers, it was determined that a standard of 0.01 gr/dscf is an appropriate emission rate. As such, all baghouses used to control particulate emissions from the handling and storage of limestone will achieve an outlet emission rate of 0.01 gr/dscf.

5.10.3 Fly Ash Handling Equipment

Fly ash collected in the air heater hoppers and the fly ash collected in the baghouse hoppers will be conveyed to the fly ash storage silo. The fly ash will be pneumatically conveyed from hoppers to the silos, and baghouses will be used to control emissions at each transfer point. Baghouses offer the highest level of control and are chosen as BACT for the ash transfer points.

Fly ash is different chemically and physically from both limestone and coal dust. It is more difficult to achieve ultra-low emission rates for fly ash than it is for coal or limestone because of the small particle size of fly ash. After review of different baghouse vendors and equipment suppliers, it was determined that the industry standard of 0.01 gr/dscf is an appropriate emission rate. As such, all baghouses used to control particulate emissions from the transportation and handling of fly ash will achieve an outlet emission rate of 0.01 gr/dscf.

Fly ash in the storage silo can be conditioned (i.e. wetted) and loaded into open bed trucks for transport to an onsite or offsite landfill.

5.11 Cooling Tower

Particulate emissions occur from the cooling tower as a result of the total solids (suspended and dissolved metals and minerals) in the water droplets entrained in the air stream leaving the cooling tower. These droplets of water (containing particulate) are known as drift. While the majority of the suspended water and particulate are deposited in or near the tower, some of the drift can exit through the top of the tower and enter the air as PM_{10}. The most efficient way to remove drift from cooling towers is by installing drift eliminators. Drift eliminators are designed to remove as many droplets as feasible before the air stream and entrained particulate leave the cooling towers.

Drift eliminators to control drift emissions to 0.0005 percent of the water flow through the cooling tower have been selected as BACT for particulate matter control on the cooling tower. This represents the highest or “top” option for BACT, and in accordance with EPA guidance, no further control techniques were considered.

5.12 Diesel Internal Combustion (IC) Engines

5.12.1 Emergency Fire Pump

The emergency fire pump will fire low sulfur diesel fuel (≤0.05 percent sulfur) and will be limited in operation to 500 hours per year. The use of add-on controls for VOC and PM_{10} emissions has not been documented in the RBLC for diesel engines similar to these units. Good combustion practices and proper maintenance procedures will be used to limit VOC and PM_{10} emissions from these engines.

The RBLC does not list CO add-on controls for engines of this size, however, a control vendor has indicated that a CO catalyst system may be used on a unit this size while burning diesel fuel. The CO catalyst system is an add-on control that converts CO to CO_2 by use of a catalyst. Add-on controls for CO are estimated to cost more than $10,000 per ton of CO removed, making them economically infeasible for diesel engines of this size. Consequently, CO catalyst has been eliminated as a possible CO emission reduction strategy. The proposed BACT control method for CO for the diesel fire pump is good combustion practices. The use of good combustion practices will keep the emission of other criteria pollutants to low levels as well.

5.12.2 Diesel Generator

The diesel generator will fire low sulfur diesel fuel (8,760 hours per year potential). The use of add-on controls for VOC and PM_{10} emissions has not been documented in the RBLC for diesel engines similar to these units. Good combustion practices and proper maintenance procedures will be used to limit VOC and PM_{10} emissions from these engines.

The RBLC does not list CO add-on controls for engines of this size, however, a control vendor has indicated that a CO catalyst system may be used on a unit this size while burning diesel fuel. The CO catalyst system is an add-on control that converts CO to CO_2 by use of a catalyst. Add-on controls for CO are estimated to cost more than $10,000 per ton of CO removed, making them economically infeasible for diesel engines of this size. Consequently, CO catalyst has been eliminated as a possible CO emission reduction strategy. The proposed BACT control method for CO for the diesel fire pump is good combustion practices. The use of good combustion practices will keep the emission of other criteria pollutants to low levels as well.

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6.0 AIR DISPERSION MODELING

Since this project is subject to PSD review, an air dispersion modeling analysis is required for each pollutant subject to 40 CFR Part 52.21. According to the emission estimates for this project, CO and PM_{10} are subject to PSD review, and an air quality analysis was performed for each. Since VOCs are photoreactive pollutants and are generally regional in nature in terms of their contribution to ozone formation, no reactive-pollutant modeling of VOCs was conducted. In addition, Big Stone II requests that a pre-construction ambient ozone monitoring study not be required since potential VOC emissions are expected to be less than 100 tpy.

The results of the modeling indicate that the impacts of CO from Big Stone II will not result in a significant impact at any location. According to the draft "New Source Review Workshop Manual," no further modeling is required for a PSD applicant if the modeled impacts are below the significance levels. However, the modeling analyses show that Big Stone II's emissions exceed the PSD *de minimis* modeling significance thresholds for PM_{10}. A refined modeling analysis will be conducted for the annual PM_{10} averaging period and the 24-hour PM_{10} averaging period to demonstrate compliance with the National Ambient Air Quality Standards (NAAQS) and PSD Class II Increments.

6.1 Air Dispersion Model

Air dispersion modeling was performed using the latest version of the ISCST3 model (Version 02035). The ISCST3 model is an EPA-approved, steady state, Gaussian air dispersion model that is designed to estimate downwind concentrations from single or multiple sources using supplied meteorological data. The ISCST3 model is used for most industrial sources and PSD permits and is an appropriate model for this type of industrial facility.

Major features of the ISCST3 model are as follows:

- Plume rise due to momentum and buoyancy as a function of downwind distance for stack emissions;
- The influence of building wakes on plume transport and dispersion as evaluated by the Huber and Snyder Method for physical stack heights that are greater than $h_b + 0.5(l_b)$, where h_b is the

building height and l_b is the lesser of the building height or width, and by the Schulman and Scire Method for stack heights that are less than or equal to $h_b + 0.5(l_b)$;

- Regulatory default option;
- Buoyancy-induced dispersion algorithm;
- Calm wind treatment of meteorological data;
- Procedures suggested by Briggs for evaluating stack-tip downwash;
- Default wind profile exponents;
- Default vertical potential temperature gradient;
- Consideration of the effect of gravitational settling and dry deposition on ambient particulate concentrations;
- Capability of simulating line, volume, and area sources;
- Concentration estimates for 1-hour to annual average; and,
- Adjustment procedures for complex terrain.

Details of the modeling algorithms contained in the ISC model may be found in the User's Guide for ISC. The regulatory default option was selected for this analysis since it met the USEPA guideline requirements. Further specifications, detailed in the air dispersion modeling analysis protocol, submitted to DENR on March 25, 2005 can be found in Appendix E of this report.

6.2 Model Stack Parameters

6.2.1 Big Stone II

Modeling runs were conducted at full load and partial loads to confirm that operation of Big Stone II will not result in impacts greater than the NAAQS or PSD increments. The stack parameters used in the analysis are given in Table 6-1. Emission rates for each of the pollutants at each operating load are given in Table 6-2.

Table 6-1: Big Stone II – Boiler Stack Parameters

Stack Height	Stack Diameter	Stack Temp. (°F)	Exit Velocity (ft/s)			
			100% Capacity	75% Capacity	50% Capacity	25% Capacity
498 ft	34 ft	131	72.76	65.35	57.69	47.96

Table 6-2: Boiler Potential Emission Rates

Pollutant	Capacity Emissions (lb/hr)			
	100%	**75%**	**50%**	**25%**
CO	960.00	720.00	480.00	240.00
PM_{10}	788.40	591.30	394.20	197.10

All emissions were modeled to correspond to their BACT emission levels.

6.2.2 Rotary Car Dumper

Big Stone II is modifying the existing rotary car dumper (#7a, b, c, and d) to have a stack height of 31.25 feet, no rain cap, and a grain loading of 0.01 gr/dscf.

6.2.3 Haul Roads

The haul road segments in the model are designated as "PR…" or "RR…" depending on whether the road is currently a paved road or a rock road. However, all haul roads will be paved as part of the Big Stone II project. Paved road emission factors were used to calculate the emissions from all haul road segments. Figures 6-2 through 6-9 show the road layouts.

Figure 6-1: Unit 1 Tire (Alternate Fuel) Haul Road

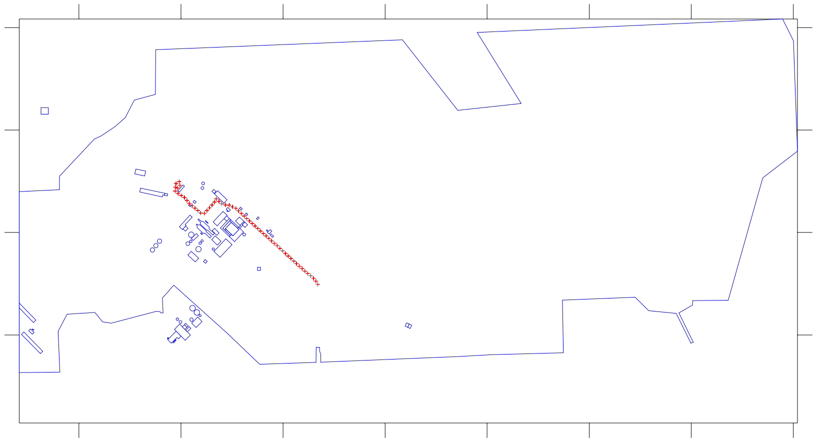


Figure 6-2: Common Haul Road to Main Entrance and Landfill Road

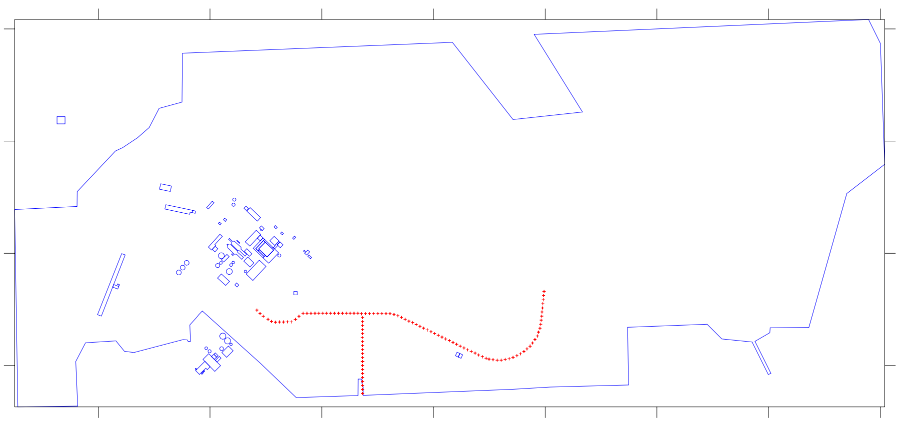


Figure 6-3: Gypsum Haul Road

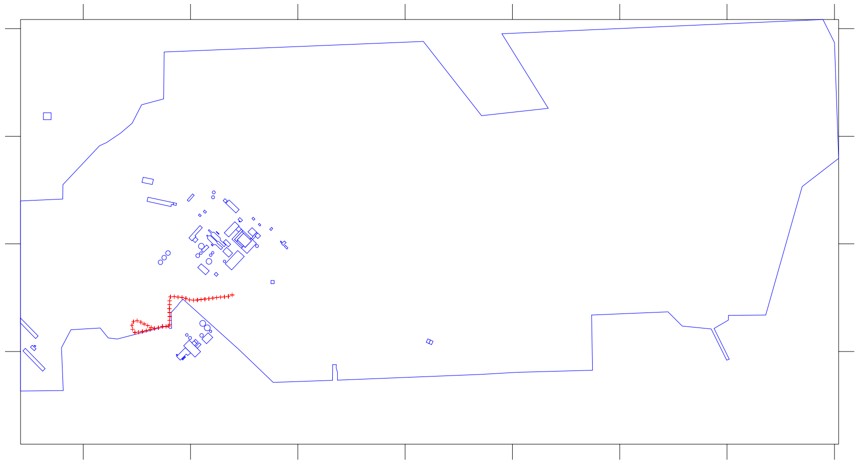


Figure 6-4: Limestone Haul Road

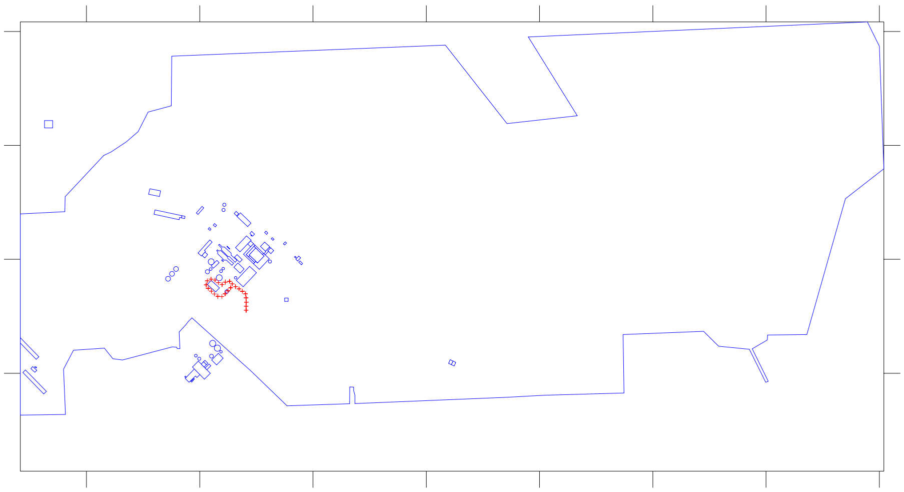


Figure 6-5: Unit 1 Fly Ash Haul Road

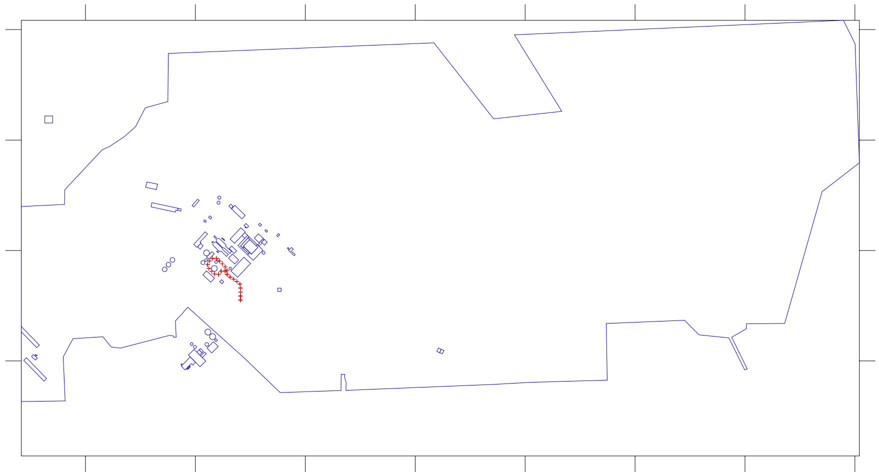


Figure 6-6: Unit 2 Fly Ash Haul Road

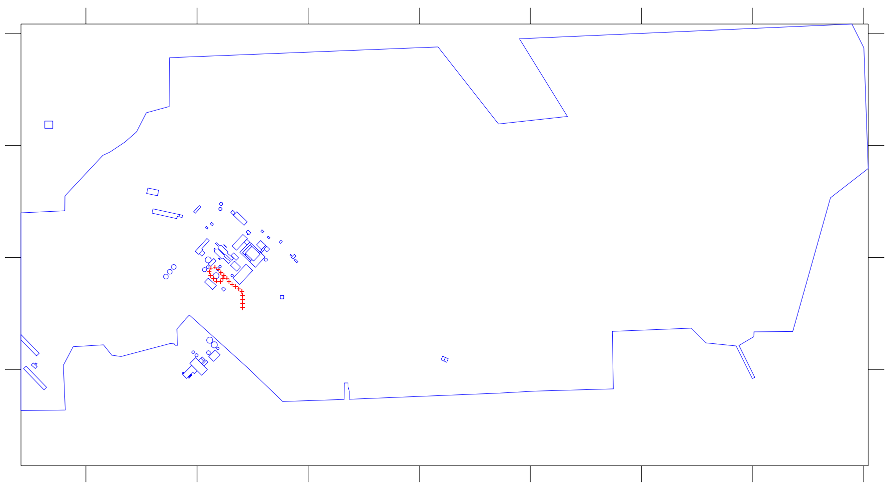


Figure 6-7: Unit 1 Bottom Ash Haul Road

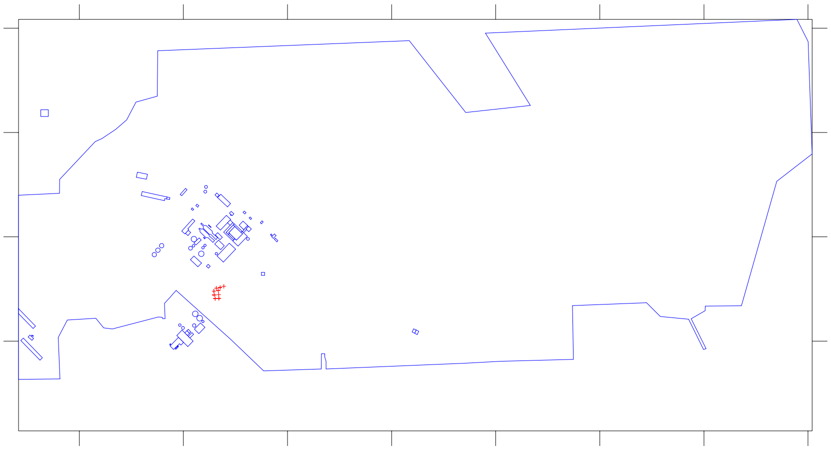
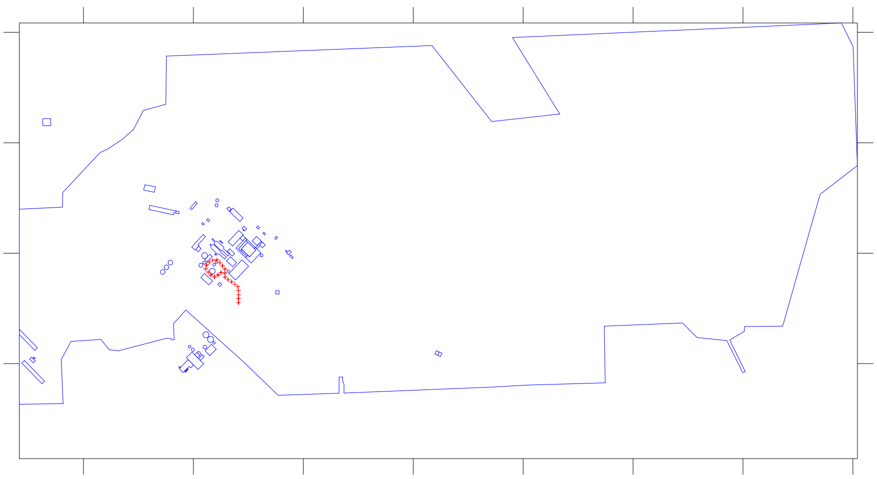


Figure 6-8: Unit 2 Bottom Ash Haul Road



6.3 Good Engineering Practice

Sources included in a PSD permit application are subject to Good Engineering Practice (GEP) stack height requirements outlined in 40 CFR Part 51, Sections 51.100 and 51.118. As defined by the regulations, GEP height is calculated as the greater of 65 meters (measured from the ground level elevation at the base of the stack) or the height resulting from the following formula:

$$GEP = H + 1.5L$$

Where,

H = the building height; and

L = the lesser of the building height or the greatest crosswind distance of the building - also known as maximum projected width.

To meet stack height requirements, the point sources were evaluated in terms of their proximity to nearby structures. The purpose of this evaluation was to determine if the discharge from the stack will become caught in the turbulent wake of a building or other structure, resulting in downwash of the plume. Downwash of the plume can result in elevated ground-level concentrations. EPA provides guidance for determining whether building downwash will occur in *Guideline for Determination of Good Engineering Practice Stack Height* (EPA, 1985). The downwash analysis was performed consistent with the methods prescribed in this guidance document.

The downwash analysis was completed using EPA's Building Profile Input Program (BPIP) model (Version 04112). The BPIP model provides direction-specific building dimensions to evaluate downwash conditions. Big Stone II will be located in a rural area and the only buildings that could potentially affect emissions from Big Stone II are the on-site structures.

Nearby structures, which were expected to influence building downwash, include the boiler building, turbine building, and ancillary structures. After running an initial BPIP model, it was determined that the GEP stack height for this project will exceed 65 meters. The new boiler building has a height of 255 feet (77.72 meters) and a maximum projected width of 105.62 meters.[4] This maximum projected width is the crosswind width of the boiler and the turbine generator building. The two separate buildings are combined into a single building for the purposes of calculation the maximum projected width, as explained in the “User’s Guide to the Building Profile Input Program”.

[4] Numbers calculated by BPIP. See BPIP output file for further details.

> "Two structures 'overlay' each other when the most east and the most west corners of two structures are exactly upwind and downwind of each other, respectively. Combining of two structures that overlay each other produces the same areas of influence as if the structures had not been combined. To simplify BPIP, overlaying structures are combined in the program. Also, when the projected widths of the sufficiently close structures (tiers) do not completely overlay each other, the structures are combined and the gap between the two structures is treated as if the gap had been filled with a structure equal in height to the lower structure. Otherwise, the two structures are processed separately. Only those tiers that are sufficiently close initially are combined. Already-combined-tiers that become sufficiently close to other structures are not further combined." Page 2-10

Using the GEP formula above yields the following relation:

$$GEP = H + 1.5L = 77.72\text{ m} + 1.5 * (77.72\text{ m}) = 194.31\text{ m}$$

Once GEP has been calculated, it is necessary to determine if the stack falls within the influence of the structure. EPA guidelines indicate that any structure within 5 times L (but less than 800 meters from the trailing edge of the structure) can affect the source. In this case, L was conservatively determined to be 77.62 m, yielding 5L = 388.1m (1,273 feet). Referring to Figure 2-1, the stack for Big Stone II is to be located approximately 134 m (440 feet) from the boiler building. The stack location is within 5L, allowing the GEP for this source to exceed 65m and be raised to 151.8 meters. The stack height of 498 feet (151.8 meters) for Big Stone II is therefore within the allowable GEP for this project.

6.4 PM_{10} Modeling Setup

The PM_{10} sources can be broken into two distinct groups – point sources and fugitive sources. The point sources included the following:

- Cooling Tower
- Combustion Units
  - Boilers
  - Diesel generators
  - Diesel fire pumps
- Fly Ash:
  - Storage
  - Loading
  - Dust Collectors
- Lime:
  - Unloading
  - Storage
  - Dust Collectors
- Coal:
  - Unloading
  - Transfer
  - Dust Collectors

The emission calculations are contained in Appendix C.

Additionally, fugitive sources will generate PM_{10} emissions in conjunction with the new boiler. Fugitive emissions will arise from the following operations:

Haul Roads:	Storage Piles:
• Lime	• Wind Erosion
• Fly Ash	• Pile Maintenance
• Bottom Ash	
• Tires (Biofuel)	

Emissions from the haul roads are described in the "Fugitive Emissions Protocol," included in Appendix F.

For the purposes of the air dispersion modeling analysis, volume sources are used to represent the emissions from haul roads and any open conveyor drop points. Area sources are used to represent fugitive emissions from the coal storage piles and the landfill. As the parameters for volume sources are defined in the ISCST3 user manual, haul roads are assumed to be 30 feet (9.144 m) wide; therefore a 30-foot by 30-foot volume source can be assumed. This allows the haul road to be broken up into segments aligned in 30-foot by 30-foot segments. The ISCST3 Model allows the user to either have haul roads situated directly next to each other (exact representation) or with a space between them the size of one volume source (approximate representation). The approximate representation was used for these runs to minimize the number of sources and decrease computational time. A 30-foot (9.144 m) road width corresponds to an initial lateral dimension of 8.51 m (2 · 9.144 m ÷ 2.15m). It is assumed that the trucks hauling the fly ash are 10 feet (3.048 m) high, making the initial vertical dimension 1.42 m (3.048 m ÷ 2.15). The release height corresponds to approximately the top of the wheel (1.0 m).

For the area sources, the dimensions of each pile approximates the area that each of the piles covers. Fugitive emissions from these sources were estimated from the AP-42 section on industrial wind erosion.[5]

Both the point and volume sources were modeled to correspond to the boiler operating at 100 percent capacity. During the runs where the boiler will be operating at 75, 50, or 25 percent capacity, the fugitive emission sources will remain at emission levels corresponding to 100 percent unit load. While this method does not accurately reflect the operations at the facility, the results of the model will yield a worst-case impact scenario.

[5] AP-42 Section 13.2.5, *Industrial Wind Erosion* (1/95 Update).

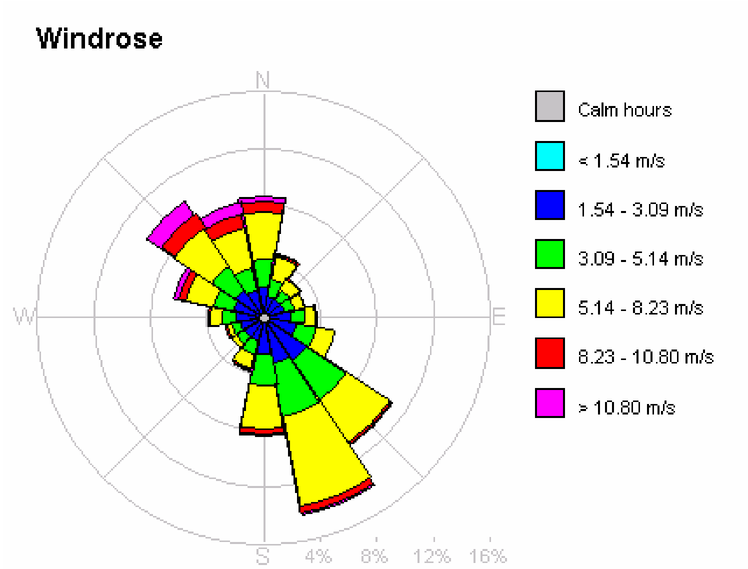
6.5 Receptor Grid

The overall purpose of the modeling analysis is to ensure that operation of the proposed facility will not result in, or contribute to concentrations above the National Ambient Air Quality Standards (NAAQS) or PSD Class II increments. The modeling runs were conducted using the ISCST3 model in simple terrain within a 10 by 10 kilometer Cartesian grid to determine the significant impact area for each pollutant. The grid incorporated the following spacing between receptors: 100-meter out to 2 kilometers, 250-meter out to 5 kilometers, and 1,000-meter out to 10 kilometers. If the significant impact area exceeded 10 kilometers the grid would have been extended to encompass the entire significant impact area. If the modeling impacts show “hot spots” outside 1,000 meters, 100-meter grid spacing would be used to encompass the maximum concentrations to ensure that the maximum impact has been identified. Receptors were also placed along the property boundary at a spacing of 50 meters. After reviewing the topography of the area, it was determined that terrain elevations should be incorporated into the model. Therefore, the appropriate United States Geological Survey (USGS) 7.5 minute topographical maps (from electronic DEM data) were used to obtain the necessary receptor elevations.

6.6 Meteorological Data

Surface air meteorological data from Huron, SD (14936) with Aberdeen, SD (14929) upper air data from 2000-2004 was used in the analysis. The anemometer height is 20 feet. The dominant wind direction is shown in Figure 6-1. The raw data had missing values for a five hour period on February 9, 2002 (hours 13 through 17). These values were filled in using data from the same time period from Mitchell, SD.

Figure 6-9: Big Stone Power Plant Windrose



6.7 Rural Dispersion Coefficients

Based on the Auer scheme, the existing land use for a three-kilometer area surrounding the proposed site is more than 50 percent rural. The population density is also less than 750 people/km^2 for the same area. Rural coefficients are appropriate for the Big Stone II area. Therefore, rural dispersion coefficients were used in the ISCST3 Model.

6.8 Cavity Analysis

The ISCST3 program cannot model impacts that occur within the cavity regions of building downwash. Calculations of the cavity distance indicated that there were no predicted concentrations at an ambient receptor, and it was therefore not necessary to include the cavity concentrations in the final modeling analysis. The calculations from the cavity analysis can be found in Appendix G.

6.9 Significant Impact Area Determination

The ISCST3 model was run for the proposed facility using the worst-case capacity scenario for the coal-fired boiler. If any modeled pollutant results in an impact below the significance levels for each averaging period, no further modeling for that pollutant to determine compliance with the NAAQS or PSD Class II increments is needed. However, if the model predicts impacts at or above the modeling significance level for any pollutant, a cumulative analysis including all point sources within the radius of impact (ROI) will be required for that pollutant. Based on the initial modeling results, Big Stone requested from DENR an emission inventory of PSD increment-consuming sources and NAAQS sources that are located within the ROI and should be included in the modeling analyses.

6.10 NAAQS and Class II Increment Analysis

For the NAAQS and PSD increment analysis, all major stationary sources that emit pollutants subject to this analysis and located within 50 kilometers of the ROI were addressed. A source within 50 kilometers of the impact area may be eliminated from the analysis if it is determined to have a negligible contribution to air quality impacts at the generating station. Big Stone consulted with the DENR to determine acceptable methods of eliminating sources from the analysis. Background air quality values for Grant County are available from the DENR to add to model-predicted concentrations for comparison to the NAAQS and are shown in Table 6-3. If the refined analysis does not result in any concentrations above the NAAQS or PSD increments, no further modeling will be conducted.

Table 6-3: Background Levels (μg/m^3)

PM_{10} 24 Hr	PM_{10} Annual
32	12.1

6.11 Ambient Monitoring

The modeling analysis for emission sources at the proposed Big Stone facility also addressed the pre-construction monitoring provision of the PSD regulations. The regulations specify significant monitoring levels for each PSD pollutant that triggers the requirement to perform one year of pre-construction ambient air monitoring. For any impacts predicted to be below the monitoring significance levels, Big Stone will request an exemption from pre-construction ambient air monitoring. If any predicted concentrations reaching or exceeding the monitoring *de minimis* levels are observed, Big Stone will consult with the DENR to determine if pre-construction ambient air monitoring will be required. If so, Big Stone will request local ambient monitoring data to fulfill the pre-construction monitoring provisions of the PSD regulations or develop an acceptable monitoring plan. Table 6-4 shows the NAAQS, modeling/monitoring significance levels, and PSD increments.[6]

Table 6-4: NAAQS, Significance Levels and Class I and II Increments (μg/m^3)

Pollutant	Averaging Period	NAAQS	Modeling Significance Level	Monitoring Significance Level	PSD Class II Increments
CO	8-hour	10,000	500	575	NA
	1-hour	40,000	2,000	NA	NA
PM_{10}	Annual	50	1	NA	17
	24-hour	150	5	10	30

6.12 Screening Model Results

After examining the modeling results at all load levels, it was determined that exceedances of the annual modeling significance level occurred, and that refined modeling would be required. All predicted impacts were lower than the ambient air monitoring *de minimis* level and no pre-construction monitoring was required. The maximum modeled concentrations are given in Table 6-5. The model input and output files are provided on CD-ROM in Appendix G.

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[6] The pollutants that are allowed one NAAQS exceedance per year and one PSD Increment exceedance per year are: 1-hour and 8-hour CO and 24-hour PM/PM_{10}.

Table 6-5: Screening Level Maximum Modeled Concentrations

Pollutant	Averaging Period	UTM Coordinates (meters)		Year	Predicted Concentration ($\mu g/m^3$)	Significance Level ($\mu g/m^3$)
		East	North			
CO	1-hour	694965.50	5019243.00	2002	757.93	2,000
	8-hour	694965.50	5019243.00	2002	119.75	500
PM_{10}	24-hour	694675.5	5020015	2002	**35.19**	5
	Annual	694965.5	5019243	2004	**5.38**	1

6.13 NAAQS Modeling Results

After examining the modeling results, it was determined that Big Stone II will not cause the NAAQS to be exceeded at any point where the facility will have a significant impact. Table 6-6 lists the results from the NAAQS analysis.

Table 6-6: PM_{10} NAAQS Modeling Results ($\mu g/m^3$)

Averaging Period	NAAQS	Maximum Modeled Impact: All NAAQS Sources				Background Concentration	Total Concentration
		Easting	Northing	Year	Concentration		
24-hour	150	694965.50	5019243.00	2002	104.74	32.0	136.74
Annual	50	694965.50	5019243.00	2002	19.35	12.1	31.45

6.14 Class II Increment Modeling Results

After examining the modeling results, it was determined that Big Stone II will not cause the PSD Increment to be exceeded at any point where the facility will have a significant impact. Table 6-7 lists the results from the NAAQS analysis.

Table 6-7: PM_{10} Increment Modeling Results ($\mu g/m^3$)

Averaging Period	PSD Increment	Maximum Modeled Impact: All NAAQS Sources			
		Easting	Northing	Year	Concentration
24-hour	30	694752.9	5020110	2002	29.64
Annual	17	694965.5	5019243	2004	5.38

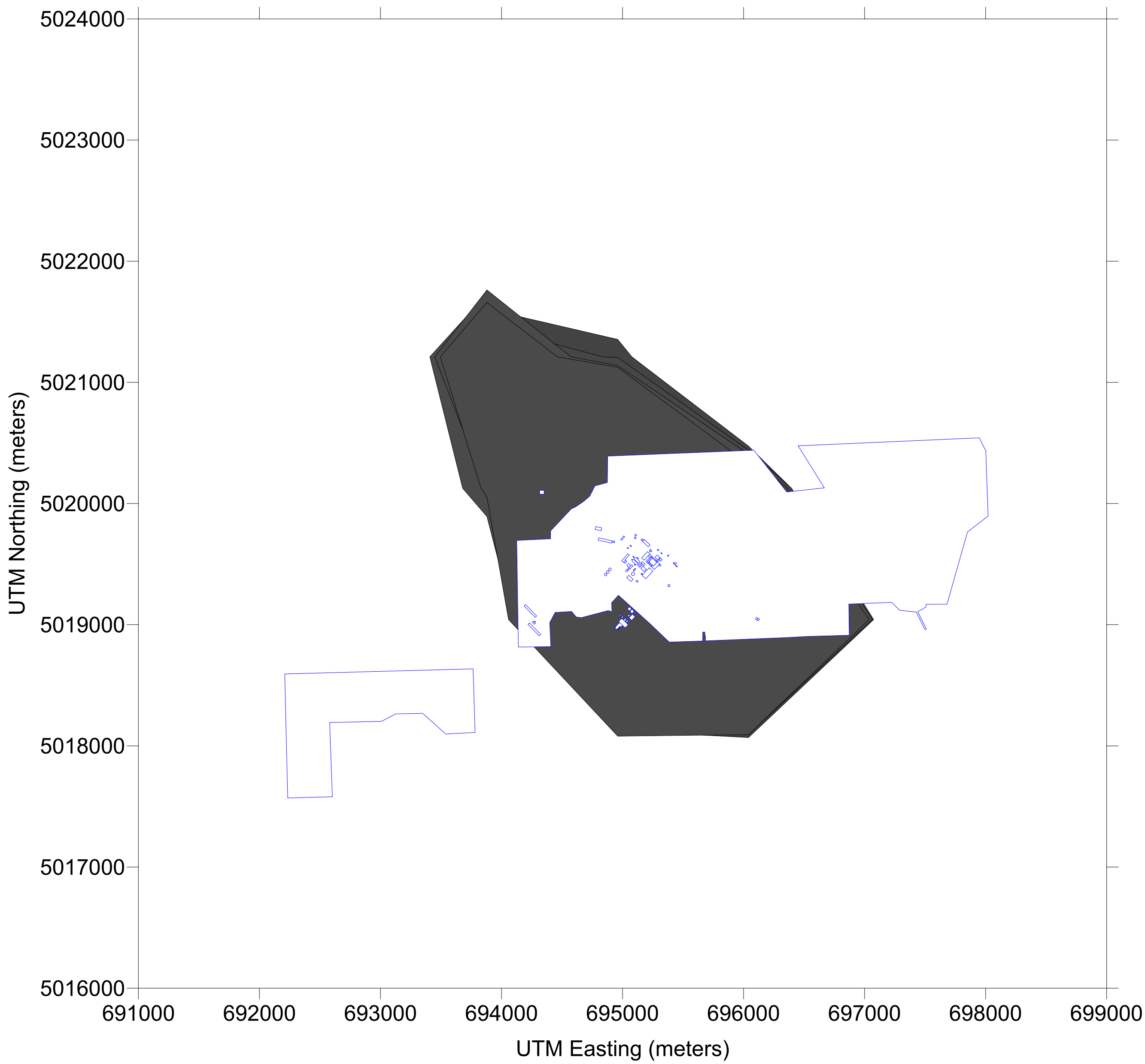
6.15 Concentration Contour Plot

Per DENR's request, the concentration contour plots for PM_{10} annual average at 1 $\mu g/m^3$ is shown in Figure 6-10.

6.16 Conclusion

The dispersion modeling predicts that there will be no exceedances of the Increment and NAAQS thresholds. The operation of the Big Stone II Project will not cause or contribute to a significant degradation of ambient air quality. After examining the results of the model, it has been determined that the PSD modeling requirements for CO and PM_{10} have been met and no further modeling is required.

Figure 6-10: PM_{10} Annual Average (1μg/m^3)



7.0 ADDITIONAL IMPACTS

The additional impacts analysis requirement under PSD assesses the ambient air quality impact analysis, soils and vegetation impacts, visibility impairment, and growth analysis for the project.

7.1 Construction Impacts

Construction of Big Stone II has the potential for short-term adverse effects on air quality in the immediate area around the site. Diesel fumes from construction vehicles and dust from site preparation and construction vehicle operation can affect local air quality during certain meteorological conditions. However, these instances are limited in time and area of effect.

The Grant County area is in attainment or is unclassified for all criteria pollutants. Operation of construction vehicles is not expected to significantly affect ambient air quality. During dry periods, fugitive dust will be minimized through the application of water to on-site roads used by construction equipment.

7.2 Vegetation Impacts

Vegetation in the region of eastern South Dakota and western Minnesota was historically dominated by tallgrass prairie in an area referred to as the Prairie Parkland Region[7]. Glaciation left this area with a mosaic of rolling glacial till uplands and pothole depressions. In areas that haven't been developed or converted to cropland, tallgrass prairie dominates the drier, exposed upland areas and commonly consists of big bluestem (*Andropogon gerardii*), Indian grass (*Sorghastrum nutans*), little bluestem (*Schizachyrium scoparium*), switchgrass (*Panicum virgatum*), prairie dropseed (*Sporobolous heterolepis*), and porcupine grass (*Hesperostipa spartea*). Areas that are more protected from dry, hot conditions by moisture or east- to north-facing slopes more commonly consist of savannas, woodlands or forests dominated by oaks (*Quercus* spp.), eastern cottonwood (*Populus deltoides*), ash (*Fraxinus* spp.), and willows (*Salix* spp.).

[7] Faber-Langendoen 2001

The following sections briefly describe the potential effects of NO_2, SO_2, CO, and PM_{10} produced by Big Stone II on the nearby vegetation. The potential effects of the air emissions to vegetation within the immediate vicinity of the Big Stone Power Plant were compared to scientific research examining the effects of pollution on vegetation. Damage to vegetation often results from acute exposure to pollution, but may also occur after prolonged or chronic exposures. Acute exposures are typically manifested by internal physical damage to leaf tissues, while chronic exposures are more associated with the inhibition of physiological processes such as photosynthesis, carbon allocation, and stomatal functioning.

7.2.1 Sulfur Dioxide

Short- and long-term exposure to sulfur dioxide has been shown to have detrimental effects on many plant species[8]. Numerous studies have been conducted studying the effects of SO_2 on vegetation including crop plants[9], trees and shrubs[10], and herbaceous plants[11]. Symptoms of SO_2 injury in leaves manifest as interveinal necrotic blotches in angiosperms and red brown banding in gymnosperms[12]. A number of the plants studied include those found in the Prairie Parkland Region or are raised for agriculture in the area. Plants include red cedar (*Juniperus virginiana*), oaks, sumacs (*Rhus* spp.), ash, raspberries (*Rubus* spp.), American elm (*Ulmus americana*), red maple (*Acer rubrum*), black willow (*Salix nigra*), bracken fern (*Pteridium aquilinum*), soybean (*Glycine max*), and corn (*Zea mays*). Injury threshold concentrations varied by species and dose (131-5,240 $\mu g/m^3$ for 8 hours, 393-3,930 $\mu g/m^3$ for 2 hours, and 1,310 $\mu g/m^3$ for 4 hours), and were significantly higher than the SO_2 emissions expected to occur near the Big Stone Power Plant. Even lichens and bryophytes, which are pollution bio-indicators due to their well-documented sensitivity to air pollution, would not be affected by long term exposure to SO_2 emissions from Big Stone II. They do not experience injury, decreased abundance, or lowered CO_2 uptake until SO_2 concentrations reach 5 to 40 $\mu g/m^3$ SO_2[13], 13 to 26 $\mu g/m^3$ SO_2[14], and 400 $\mu g/m^3$ SO_2[15] annually.

8 See reviews by Heath 1980; Kozlowski and Constantinidou 1986; Darrall 1989

9 Guderian and Stratman (1968) in Kozlowski and Constantinidou 1986; Huang et al. 1976; Reinert et al. 1975; Tingey et al. 1971; Darrall 1989

10 Linzon 1986; Kozlowski and Constantinidou 1986; Darrall 1989

11 Winner and Mooney 1980; Westman et al. 1985; Darrall 1989

12 Kozlowski and Constantinidou 1986

13 Will-Wolf 1980; Holopainen 1984; McCune 1988; and Treshow and Anderson 1989

14 LeBlanc and Rao 1975; Wetmore 1988

15 Hart et al. 1988

7.2.2 Nitrogen Oxides

During fuel combustion, atmospheric nitrogen is oxidized to nitrogen oxide and small amounts of NO_2[16]. The NO is photochemically oxidized to NO_2, which is then subsequently consumed during the production of ozone and peroxyacetyl nitrates (PANs). As with SO_2 emission research, NO_2 has been shown to deleteriously impact vegetation[17]. Typical leaf injury responses include interveinal necrotic blotches similar to SO_2 injury for angiosperms and red-brown distal necrosis in gymnosperms[18]. Injury threshold concentrations vary by species and dose, but are much higher than that of SO_2 as described above. In general, short term high, concentrations of NO_2 are required for deleterious impacts on plants[19]. The injury threshold for two crop plants grown in the region – tomato (*Lycopersicon esculentum*) and annual sunflower (*Helianthus annuus*) – is 4 hours at a concentration of 7,380 $\mu g/m^3$. A common, weedy plant found throughout the Prairie Parkland Region, lamb's quarters (*Chenopodium album*), was not injured for two hours at concentrations 1.9 ug/m^3 NO_2. Furthermore, short term fumigations of approximately 1 hour, 20 hours, and 48 hours at NO_2 concentrations of 940 to 38,000 $\mu g/m^3$, 470 $\mu g/m^3$, and 3,000 to 5,000 $\mu g/m^3$, respectively, have been shown to deter photosynthesis in a number of herbaceous [tomato, oats (*Avena sativa*), alfalfa (*Medicago sativa*)] and woody plants[20]. Moreover, Taylor and McLean (1970), in their review of NO_2 effects on vegetation noted that long term exposures of phytotoxic doses of NO_2 ranged from 280 to 560 $\mu g/m^3$. All the above concentrations are significantly higher than the NO_2 emissions expected to occur near the Big Stone Power Plant.

7.2.3 Synergistic Effects of Pollutants

Air pollutants are known to act in concert to cause injury to or decrease the functioning of plants[21]. Synergistic refers to the combined effects of pollutants when they are greater than is expected from the additive effect of the compounds. The inhibitory effects of SO_2 and NO_2[22], NO_2 and NO[23], NO_2 and O_3[24] and O_3 and SO_2[25] have been reported in various short-term studies for crop plants (e.g., soybean, broad bean (*Vicia faba*), annual sunflower, and tomato) and various trees that grow in the Prairie Parkland Region [e.g., eastern cottonwood, sugar maple (*Acer saccharum*), ash, and oak]. Concentrations of

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[16] Chang 1981

[17] Taylor et al. 1975; Heath 1980; Kozlowski and Constantinidou 1986; and Darrall 1989

[18] Kozlowski and Constantinidou 1986

[12] Prinz and Brandt 1985

[20] Hill and Bennett 1970; Capron and Mansfield 1976; and Smith 1981

[21] See reviews of Reinert et al. 1975; Omrod 1982

[22] White et al. 1974; Wright et al. 1986

[23] Capron and Mansfield 1976

[24] Furakawa et al. 1984; Okana et al. 1985

[25] Costonis 1970, Carlson 1979; Jensen 1981; Omrod et al. 1981

pollutants (80 to 981 $\mu g/m^3$) in these studies are substantially higher than concentrations predicted to occur near the Big Stone Power Plant. Consequently, no synergistic effects of the air pollutants are expected to inhibit vegetation at or near the Big Stone Power Plant.

7.2.4 Particulate Matter

Particulates may contain trace elements and heavy metals such as arsenic, boron, beryllium, copper, fluoride, nickel, lead, mercury, manganese, and cobalt[26]. These compounds have been shown to be detrimental to vegetation typically within the immediate vicinity of the source[27]. The most obvious effect of particle deposition on vegetation is a physical smothering of the leaf surface. This will reduce light transmission to the plant, in turn causing a decrease in photosynthesis[28]. However, only small amounts of particulate matter are emitted from power plants. Particulate matter concentrations due to operation of Big Stone II are expected to increase by 5.38 $\mu g/m^3$. These levels are considered negligible, so it is highly unlikely that particulate matter emissions will impact vegetation adjacent to the Big Stone Power Plant.

7.2.5 Carbon Monoxide

Carbon monoxide is not known to injure plants nor has it been shown to be taken up by plants. Consequently, no adverse impacts to vegetation at or near the Big Stone Power Plant are expected from CO stack emissions.

7.3 Soil Impacts

Eight soil mapping units have been identified at or in the immediate vicinity of the project site[29]. They include:

- Heimdal-Sisseton loams, 2 to 6 percent slopes (HbB)
- Heimdal-Sisseton loams, 6 to 9 percent slopes (HbC)
- Heimdal-Svea loams, 0 to 2 percent slopes (HcA)
- Heimdal-Svea loams, 2 to 6 percent slopes (HcB)
- Vallers-Tonka complex (Vc)
- Parnell silty clay loam

[26] Wangen and Turner 1980
[27] Woolhouse 1990
[28] Meteorological Service of Canada 2002
[29] Miller 1979

- Tonka silt loam (Ta)
- Vallers loam

Sulfates and nitrates caused by SO_2 and NO_2 deposition on soil can be beneficial and detrimental to soils depending on their composition. However, given the low emission impacts, Big Stone II should not significantly affect the soils on site or in the immediate vicinity.

7.4 Impacts on Threatened and Endangered Species

The following discussion on threatened and endangered species is based on Barr Engineering's assessment as contained in the South Dakota Energy Conversion Facility Siting Permit Application for Big Stone II.

> The U.S. Fish and Wildlife Service has identified three federally listed species that may occur in the project area (USFWS/Gober 2004, September 16, 2004 letter to Jeffrey Lee/Barr Engineering). They are the Bald eagle (*Haliaeetus leucocephalus*), the Topeka shiner (*Notropis topeka*), and the western prairie fringed orchid (*Platanthera praeclara*).
>
> The bald eagle, a federally threatened species, is known to occur in Grant County and throughout South Dakota. New nests appear in Grant County and in South Dakota in general each year, and the birds nest from January through August. The USFWS restricts construction within one-quarter (0.25) mile of an active bald eagle nest. A bald eagle nest was identified and mapped approximately 1700' (0.3 mile) north of the existing east water storage and cooling pond. The nest is nearly 1.5 miles northwest of the proposed Big Stone II plant site, and over 1.5 miles from the proposed cooling tower. It is nearly 3 miles northwest of the proposed new water storage pond.
>
> The Topeka shiner, a federally endangered species, is listed as a "possible" occurrence in Grant County. The species is not listed as South Dakota state threatened or endangered. The South Dakota Department of Game, Fish and Parks has no current or historic locations of the Topeka shiner in Grant County, and all known occurrences of the Topeka shiner in South Dakota are in streams south southeast of Grant County (S. Dakota Dept. of Game, Fish and Parks 2003. Topeka Shiner Management Plan for South Dakota.).

Construction of the Big Stone II plant is not likely to result in any direct, indirect or cumulative impacts on the Topeka shiner. This is because the only potential habitat for the fish, the Whetstone River, is outside of the construction limits of the project, and will receive no discharge from the plant. In the event that, prior to or during construction, the Topeka shiner is found in the Whetstone River, the South Dakota Department of Transportation Special Provisions for Construction Practices in Streams Inhabited by the Topeka Shiner (SDDOT 2003) can be implemented.

The western prairie fringed orchid, a federally threatened species, is also listed as a "possible" occurrence in Grant County. There are currently no known populations of this plant species in South Dakota. However, the species has historically been distributed throughout the tall grass prairie west of the Mississippi River in the Central United States and southern Canada, and one of the three largest remaining populations is approximately 122 miles north of the Big Stone II site. Moreover, the species' preferred habitat of mesic prairie swales exists in several small areas within the Big Stone II project area. A number of the known plant associates of the western prairie fringed orchid are also present, including big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), and several sedge (*Carex* spp.) species.

Field surveys conducted in September 2004 did not locate any populations of western prairie fringed orchid. As a result, there are currently no anticipated direct impacts on this species. Indirect impacts include loss of potential habitat, alteration of surface drainage patterns and a potential increase in non-native invasive species.

Operation of Big Stone II should not cause any adverse impacts to protected species or potential habitats since facility air emissions meet all ambient air quality standards and PSD increments.

7.5 Growth Impacts

Big Stone II is expected to increase employment in the area. The building phase will last approximately four years. Construction employment of approximately 700 workers is expected over the course of the construction period. Projected employment, reflecting full time jobs directly tied to the operation of Big Stone II, is estimated at 35 additional people at the generating station site. This will result in moderate amounts of secondary employment created by the economic activity of the plant. In the immediate vicinity of the plant and as a result of Big Stone II, residential and commercial growth will result in secondary air emissions (i.e. increased vehicular use) but are not expected to significantly impact air quality.

7.6 Class II Area Visual Impact Analysis

A visibility analysis was performed on the Pipestone National Monument in southwestern Minnesota. The visibility analysis was performed in accordance with the guidelines set forth in EPA-450/4-88-015, Workbook for Plume Visual Impact Screening and Analysis. Within the document, the model VISCREEN is recommended for plume visibility analysis. Several refinement levels of VISCREEN are described. The first level VISCREEN analysis uses worst-case meteorological conditions (F-class stability, 1 m/s wind speed). This level of screening results in the most conservative (worst-case) visibility results. If the plume visibility against the sky and terrain is below a level perceivable to the human eye, the visibility modeling is complete. Otherwise, a second level VISCREEN analysis, that uses actual meteorological data and refined particle characteristics, can be performed. The second level model will result in a more realistic visibility analysis. If this plume visibility still does not meet sky and terrain contrast levels, a third level model may be required that adds more statistical analysis.

The first level VISCREEN model was performed for Big Stone II. Emissions from Big Stone II only were considered. The inputs into the model included particulate matter, NO_X, primary NO_2, soot, and primary SO_4. The maximum annual particulate emissions from Big Stone II are 788 tons/yr[30]. The corresponding NO_X emission rate is 1,840 tons/yr.

According to the workbook, primary NO_2, soot, and primary SO_4 can be assumed to be zero except for very specific sources. Since the power plant is not one of the specified sources, the emissions for the last three species (primary NO_2, soot, and primary SO_4) are assumed to be zero. The next set of inputs into the level one VISCREEN model considers the distance between the source, observer and area, and the background visual range. The distance between the source and observer is 145 kilometers.

Background visibility was determined from the VISCREEN manual to be 40 kilometers. The last inputs into the model are particle sizes, background ozone, plume-source-observer angle, stability, and wind speed. All of these inputs are automatically set if the default option is chosen. For the level one analysis, the workbook tells the analyst to choose the default option, which sets the following particle sizes:

[30] Emissions are only from the boiler. Not including emissions from materials handling or fugitive emissions.

- background fine = 0.3 μm diameter, 1.5 g/cm^3 density
- background course = 6 μm diameter, 2.5 g/cm^3 density
- plume particulate = 2 μm diameter, 2.5 g/cm^3 density
- plume soot = 0.1 μm diameter, 2 g/cm^3 density
- plume primary sulfate = 0.5 μm diameter, 1.5 g/cm^3

The background ozone is 0.04 parts per million (ppm), the plume-source-observer angle is 11.25 degrees, the worst case atmospheric stability is an F stability class, and the worst case wind speed is 1 m/s.

The VISCREEN model output compares the calculated Delta E and contrast from the plume to present default comparison values. Delta E is the color difference parameter used to characterize the perceptibility of the plume on a color difference between the plume and a viewing background such as the sky, a cloud, or a terrain feature. Color differences are due to differences in three dimensions: brightness (L*), color hue (a*), and saturation (b*). Delta E is calculated for several lines of sight. A green contrast analysis is also performed for various lines of sight using a green wavelength and contrasting the plume with the terrain and sky backgrounds. The critical E value is 2.0 and the green contrast value is 0.05.

The results of the Level 1 VISCREEN model are shown in Appendix H. The visual results pass the Class I screening criteria at the Pipestone National Monument located 145 km away. With respect to visibility conditions around the plant, there are no known Class II screening visibility criteria that have been recommended at this time. Big Stone II will be constructed in a Class II area. Operation of the proposed emission sources will demonstrate compliance with state regulations restricting stack gas opacity to 20 percent. Big Stone believes that if emissions comply with these levels, no adverse visibility impacts will occur in the immediate vicinity around the plant.

7.7 Conclusion

Based upon the results presented in this section of the report, it is concluded that the construction of Big Stone II will not have a significant adverse impact on the surrounding area.

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